Materials & Methods

Selection & use of

metals, nonmetallics, parts, finishes

in product design & manufacture

December, 1955

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Industrial Textile Fibers—M & M Manual No. 122

Which Finish—Lacquer or Enamel?

Coined and Embossed Sheet Metals

Four Inorganic Papers

Sprayed Metal Coatings in Product Design

Structural Materials for Heat Transfer in Nuclear Reactors

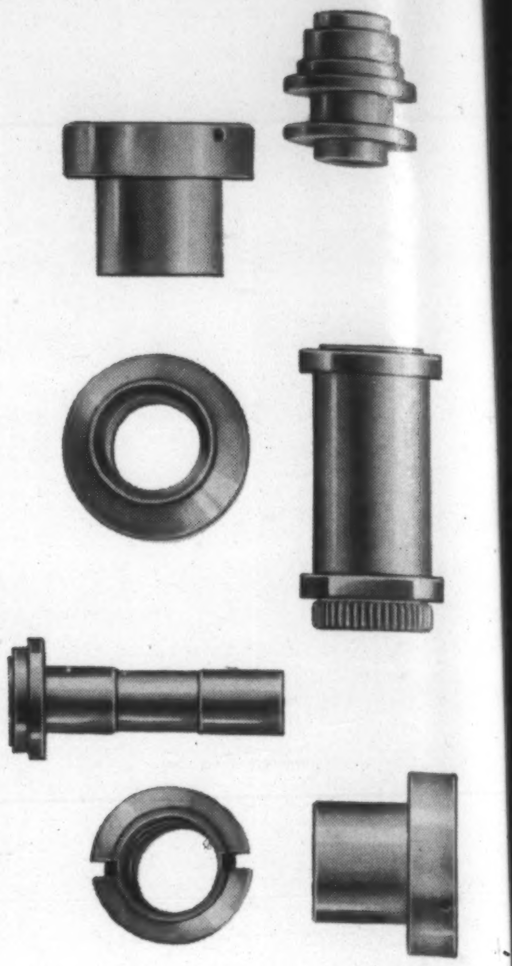
Semi-Annual Index

Complete Contents—page 1

RICE FIFTY CENTS

"Economical Buying of Screw Machine Products Now Calls for Greater Care in Specifications,"

says Leonard Schaffer, President, Mechanical Art Works, Inc., Newark, New Jersey



A few typical fine-finish, close tolerance screw machine products currently produced from ANACONDA Rods at the Mechanical Art Works.

"The tremendous versatility of automation in modern manufacturing has placed a bigger burden on the designer and buyer of screw machine parts," Mr. Schaffer explains. "The trend toward miniaturization has shifted many more parts to the screw machine. And the screw machine's ability to provide *tolerances* as close as .0005", and finishes heretofore obtainable only by centerless grinding, has left a tremendously wide choice in specifications."

Mr. Schaffer, a long-time user of Anaconda products, says, "I can count on the uniform machining characteristics of ANACONDA Rods from batch to batch, which is important for both quality and economy in my business."

For complete data on composition and machinability of standard ANACONDA Alloys, standard specifications, weights and dimensions of standard rods, write for Publication B-14. Address: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

5583

A few of Mr. Schaffer's suggestions to buyers of screw machine products for keeping costs down.

Wherever possible, the largest diameter of the piece should correspond to a standard stock rod diameter.

Avoid fancy shapes calling for expensive forming tools.

Use hole diameters obtainable with standard tools.

Allow commercial tolerances if possible, otherwise specify tolerances no closer than necessary.

Specify Standard National Coarse or National Fine Threads wherever possible.

On external threads, cutting full threads close to a shoulder is expensive —and may be unnecessary.

Tapping blind holes close to the bottom is difficult and costly.

Specify free cutting material unless special physical properties are required, then select the best machining material containing those properties.

ANACONDA® RODS FOR SCREW MACHINE PRODUCTS

For more information, turn to Reader Service Card, Circle No. 355

Materials & Methods.

Selection & use of

metals, nonmetallics, parts, finishes

in product design & manufacture

DECEMBER 1955 **VOL. 42, NO. 6**

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Materials & Methods is indexed regularly in the Engineering Index and the Industrial Arts Index

Cast for the role of resisting wear

"S" Monel Sleeves

How often have you wished you could get a wearing sleeve that would resist destructive conditions like abrasion and corrosion? Then take a look at these two sleeves.

The "S"® Monel sleeve pictured at top goes on the shaft of a salt water circulating pump.

Severe abrasion and corrosion from the sandy salt water in the gland seals used to wear out shaft sleeves in these pumps every 2½ years. Usually sooner.

Then the engineers decided to try Inco-Cast "S" Monel sleeves. *These sleeves have already withstood this abrasive and corrosive attack for nearly five years!*

Pictured in the second photo is the rotor-shaft-sleeve assembly for a midget Jordan machine. This machine processes highly abrasive raw asbestos. Ordinary sleeves were lasting only 15 months.

Then centrifugally-cast "S" Monel sleeves were tried. Judging from their appearance after more than a year's service, their owners estimate these sleeves will give "*ten times as much service*".

Unusual service like this is common when "S" Monel is used. Field records show it generally gives from three to ten times longer life than ordinary materials where service conditions involve destructive abrasion, corrosion, galling, or erosion.

Do you want to know more about this age-hardenable, corrosion-resisting casting alloy? Data on its composition, properties, and working instructions are summarized in a new bulletin, "Engineering Properties of 'S' Monel." Write for a copy today.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N. Y.

Six advantages of Inco Castings

1. You get castings that generally outlast other materials under destructive service conditions. That's because they are made of Inco Nickel Alloys, which have been especially developed to withstand corrosion, abrasion, erosion and galling.
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4. You get the benefit of Inco's help in solving your metal problems based on wide experience in field and laboratory testing of Nickel Alloys.
5. You get Inco Nickel Alloy castings made at Inco's own foundry; your assurance of sound, dependable castings.
6. Even castings you previously thought impractical to produce in Monel®, Nickel or Inconel® can often be cast by Inco's specialists.

INCO
TRADE MARK

Inco Castings Sand, Centrifugal, Precision

For more information, turn to Reader Service Card, Circle No. 480

Materials Outlook

CELLULOSE PROPIONATE molding compounds are now available in commercial quantities. This thermoplastic, first introduced by Celanese a number of years ago, has end properties similar to those of cellulose acetate butyrate. However, it has no objectionable odor, and it also has exceptionally good molding characteristics, making possible molded surfaces with fine detail and high luster.

DEVELOPERS OF HIGH-CHROMIUM ALLOYS are concentrating on chromium-iron alloys and to some extent, on chromium-nickel-nitrogen alloys. A forgeable chromium-iron alloy containing 60% chromium has tensile strength of 117,000 psi and elongation of 17% (in 1 in.). Higher creep rupture and thermal shock properties are shown by a more complex alloy containing 70% chromium, plus iron, molybdenum, titanium and aluminum. It is malleable but not ductile at room temperature. Chromium-nickel-nitrogen alloys containing 45-55% chromium also look promising, although further alloying may be necessary to raise stress rupture life to a useful level.

PIGMENTED ACRYLIC LACQUERS with much greater resistance to chalking than the commonly used nitrocellulose lacquers will be used to a limited extent on some 1956 cars. In addition to improved gloss retention, the new lacquers are claimed to make possible new color effects. . . . A NEW ALKYD BAKING ENAMEL which hardens more rapidly and is less heat sensitive than current enamels will also be used on some 1956 cars. Its resistance to discoloration resulting from multiple bakes is expected to simplify the problems of providing two- or three-tone finishes.

MORE COMPLEX PRECISION INVESTMENT CASTINGS can be produced from wax patterns now that a method of coring the pattern has been adopted by most of the industry. The cores consist of a special wax which can be dissolved out without affecting the rest of the pattern. Soluble cores offset one of the advantages of the frozen mercury process, namely the ability to "book" together two halves of a complex pattern without sacrificing dimensional accuracy. . . . Pouring into evacuated molds is gradually replacing centrifuging as an accepted technique for filling out the mold in investment casting.

THE POTENTIAL OF POWDER METALLURGY has been extended by the development of a super-hot pressing process utilizing pressures as high as 40,000 atmospheres and temperatures that may exceed 5000 F. Equipment for the Vitron process includes expendable die chambers and is designed so that compacting pressures are nearly equal in all directions. Rods having a length-diameter ratio of 10 to 1 have been made successfully. Fusion time is reduced to a matter of seconds and segregation of light or liquid phases is eliminated. . . . Such high temperatures and pressures favor certain metallurgical reactions not feasible at ordinary temperatures. Among the processes being studied is the production of titanium by direct reduction of the oxide.

HEAT RESISTANT PAINTS based on tetrabutyl titanate may be just around the corner as a result of a substantial cut in the price of the raw material some months ago. Properly pigmented, these paints can withstand continuous exposure at temperatures above 900 F.

THE 'ONE-COAT' PORCELAIN ENAMEL for steel may finally become a reality. A major appliance manufacturer has a pilot line set up to test a special dip surface treatment for ferrous metals which is claimed to eliminate the need for a ground coat. Elimination of the ground coat would make possible a thinner, more flexible and less expensive coating.

BETTER ELECTRICAL PROPERTIES in low-pressure polyester laminates can be achieved through use of the new Dacron reinforcing blankets. In one series of tests wet Dacron laminates were superior to dry glass laminates. Dacron laminates appear to have higher abrasion resistance, greater flexibility, lower strength and lower impact resistance than glass laminates. . . . CLOSEST THING TO A UNIVERSAL GLASS FINISH for low pressure laminates is one of the silane types developed by Naval Ordnance, according to a recent study by an aircraft company.

TWO NEW 'SPECS' FOR NODULAR IRON have been approved by the ASTM. One covers castings heat treated to high strength levels (A 396). The other covers nodular iron used in pressure-containing parts (A 395) and was developed by the ASME Boiler and Pressure Vessel Committee. . . . An ASTM committee has prepared a standard method for estimating grain size of metals (E 112) that will eventually supplant the several standards now recognized for different metals.

HARD, ADHERENT TITANIUM COATINGS up to 0.005 in. thick have been produced on iron and steel by fused salt electrolysis under an inert atmosphere. The experimental process utilizes a potassium titanium fluoride bath operated at temperatures ranging from 1500 to 1750 F; high currents and voltages can be used. Coatings obtained are ductile enough to permit working of the base metal. Heavier coatings can be obtained by cleaning the surface and repeating the electrolytic process.

PLASTIC TOOLING continues to grow. It is now estimated that 40% of the gages and fixtures used in the automotive industry are made of plastics.

Materials BRIEFS

Old Sport, New Materials

Racing sailors, on the alert for any advantage, have come up with titanium fittings to save weight, retard corrosion. One consistent Star class winner has titanium fittings and Dacron polyester fiber sails.

Quiet Please

Jet engine silencers have been developed that quiet the noise by forcing exhaust through small openings which convert audible frequencies to high pitched sound beyond hearing range.

No Smell, No Tarnish

Chlorophyl, of the green toothpaste variety, will prevent metal corrosion. Paper impregnated with substance absorbs hydrogen sulfide, is a promising packaging material.

Pinball Foiler

Larcenous pinball players who used magnets to influence the course of the ball have had to return to body english. Manufacturers tilted the magnet wielders by using non-magnetic stainless for balls.

Change Detector

Ultrasonic methods are in use to study the internal changes that occur in aluminum and other metals subjected to high energy nuclear radiation.

Tin Turf

Race fans in Kuala Lumpur, Malaya, are holding fast to their Turf Club laid out over rich tin deposits. Worth millions if it could be mined, companies would welcome an opportunity to move in.

Steel Nickel

Stainless steel money is being used in Costa Rica. Five and ten cent pieces are in circulation and have shown a high resistance to the wear and tear usually suffered by other metals.

want better

- HEAT RESISTANCE
- ARC RESISTANCE
- STRENGTH & WEAR RESISTANCE
- STABILITY

in molded electrical parts?

Today's new Ace Hard Rubber compounds are far more than "just good insulators" in electrical-mechanical parts. Look at these representative values: Tensile strength to 10,000 psi, moisture absorption as low as 0.04%, power factor 0.006; arc resistance as high as 190; dielectric strength to 600 v/mil; surface resistance over 10^8 megohms; heat resistance to 300 deg. F. Compounds can be blended to give just the right combination of properties for each job...economically, too, because it's never necessary to "over-design." Practically any size and shape can be molded, even with complicated inserts. Machinable to close tolerances, with excellent dimensional stability. Why not check up on today's new compounds for your designs?

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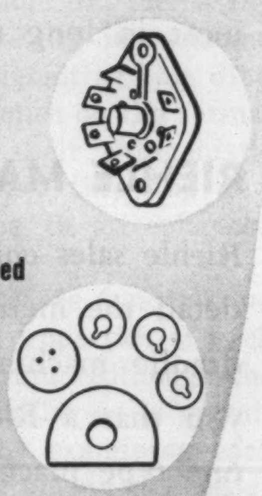

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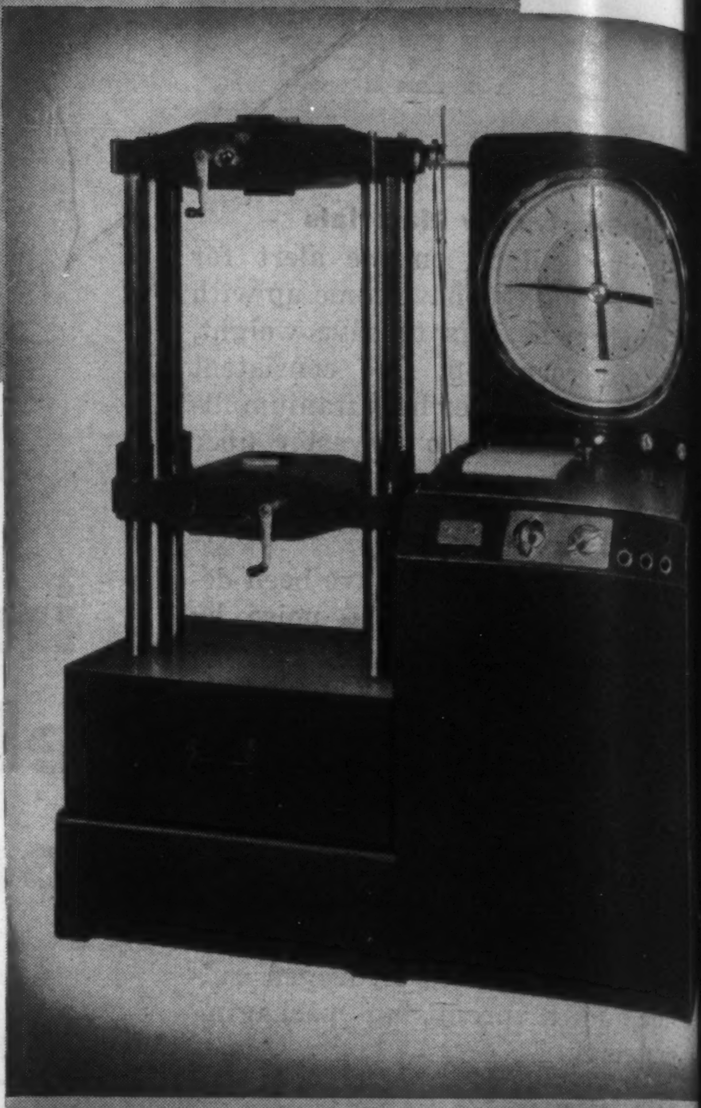
Hydraulic or Screw Power Testing Machines?

ONE MAY BE BETTER FOR YOUR PARTICULAR TESTS



Screw power universal testing machine, 60,000 p capacity. Riehle offers both screw power an draulic machines, recommending whichever is appropriate for the tests to be performed.

Do your tests require the handling of off-center loads? Do your tests require unlimited loading stroke between the upper crosshead and weighing table? Or do your tests involve holding a load indefinitely in the elastic range? If your answer to any of the questions is "yes", then a screw power machine will probably be the better choice.

On the other hand, if your requirements are for regular production and control testing, the simplified operation of a hydraulic machine will be highly advantageous. Also, a minimum of moving parts assures long service life plus the utmost in long term accuracy and dependability.

RIEHLE MAKES BOTH

Riehle sales engineers are qualified to discuss in detail the merits of both screw power and hydraulic machines — without bias. This assures you that a Riehle man will never recommend one type machine when the other would serve you better.

You'll find all Riehle equipment engineered to accommodate modern testing procedures. A complete line of accessories is available which includes: high magnification stress-strain recorders . . . rate of load indicator . . . rate of strain indicator . . . plus other accessories for specialized testing purposes. Send today for a guide to Riehle's complete modern line.

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For more information, Circle No.

Men of Materials...

Dr. Ronald C. Vickery, Section Head of Chemistry, Horizons Inc., is one of the recognized world authorities in the field of the rare earths. University of London and Oxford University trained, he was a consulting chemist in London until 1945 when he joined Hemingway & Co., of Stratford, and the London & Scandanavian Metallurgy Co. working with the rare elements. In 1950 he joined Australia's Commonwealth Scientific Industrial Research Organization, aiding in the development of the rare earth deposits. He arrived in the U.S. in Aug. 1955 to accept his present position with Horizons and is now working on industrial applications of the rare earths. He is author of "Chemistry of the Lanthanons", and "Chemistry of Yttrium and Scandium". Several textbooks and a volume on "Methods and Research" by Dr. Vickery are scheduled in the near future.

Vickery says . . .

"Rare earth applications are increasing with new knowledge"

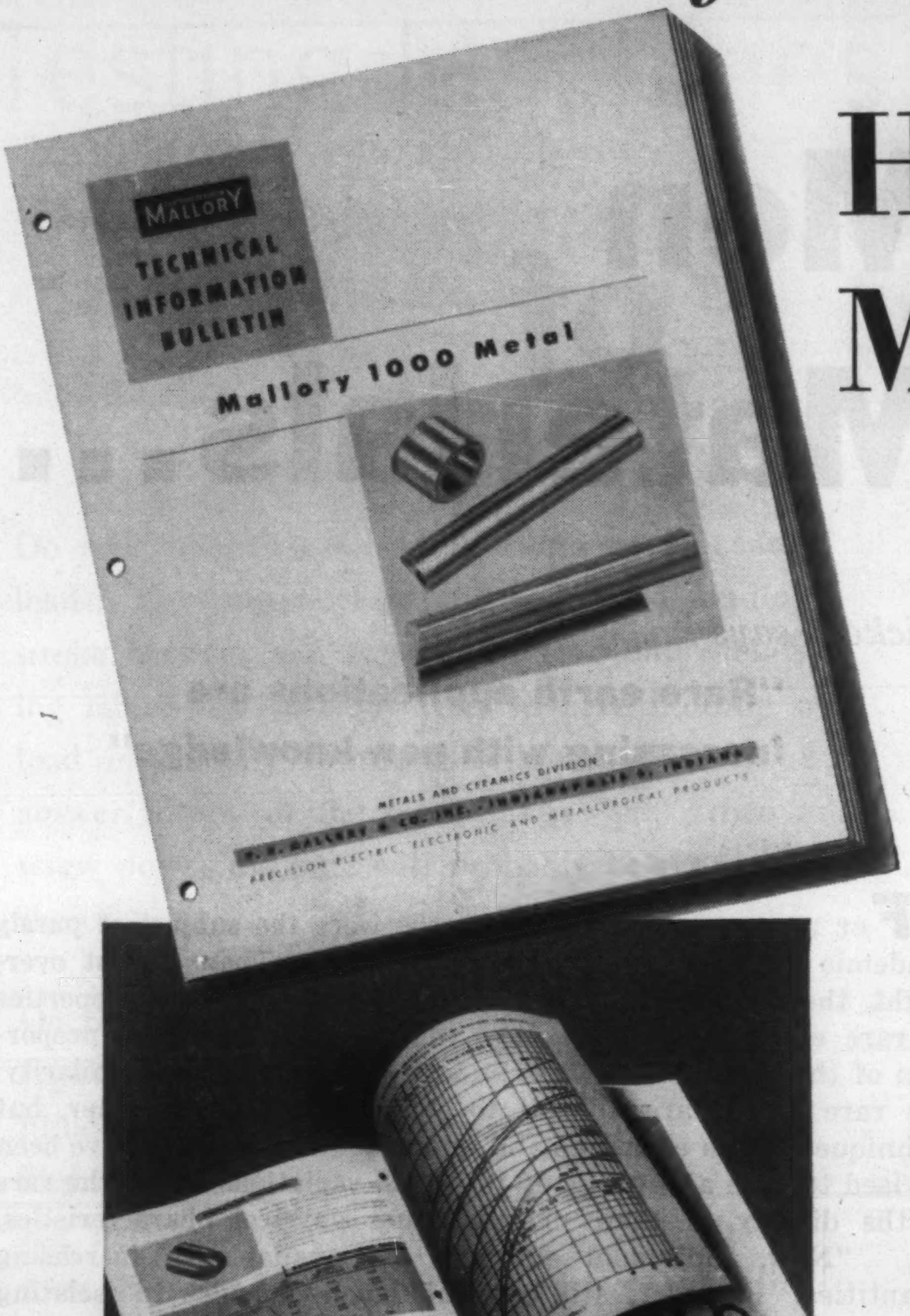
"For many years, the rare earths were the subject of purely academic interest to only a few chemists. Then, almost overnight, the atomic bomb created great interest in the properties of rare earth elements because they form such a high proportion of the 'ashes' of nuclear fission. Because of their similarity, the rare earths are difficult to separate from each other, but techniques of ion exchange and liquid-liquid extraction have been devised to take advantage of the small variations which the rare earths display in their chemical and physical characteristics.

"Now, individual elements are available in increasing quantities. However, still we find much difficulty in isolating some members of the rare earth group. Surmounting this difficulty is basic to future work in this field. Studies on the formation of complex rare earth compounds, and their antagonistic solubilities in aqueous and organic liquids are throwing new light on separation work, as well as leading to an enhanced fundamental knowledge of the elements.

"Separation is not the only problem. More fundamental work is required to determine the individual properties of each member of the group from lanthanum to lutetium. Although the properties of members of the series are so similar as to permit extrapolation from one element to another, by examining each rare earth as a single entity, we are gradually uncovering major differences in fundamental properties which can be put to good use, not only in separation techniques but also in industrial applications.

"The rare earth metal mixture—mischmetal—is well known, as is the use of cerium in stainless steels; neodymium and praseodymium in ceramics; samarium and europium in phosphors; and irradiated thulium as a convenient source of X-rays. But these, we feel, are merely the beginning. Gadolinium, dysprosium, holmium and lanthanum all possess specific properties of high potential. Many applications of the other rare earths are emerging as our knowledge of the chemistry and physics of these elements deepens."

Invaluable Reference Data on . . .


MALLORY
TECHNICAL INFORMATION BULLETIN
Mallory 1000 Metal
METALS AND CERAMICS DIVISION
P. R. MALLORY & CO. INC. • INDIANAPOLIS, INDIANA
PRECISION ELECTRIC, ELECTRONIC AND METALLURGICAL PRODUCTS

High Density Metal

In counterweights, high inertia rotors and radioactive shielding, the unique properties of Mallory 1000 Metal offer exceptional opportunities for product improvement. To help designers in the use of this unusual metal, Mallory has compiled all current technical data on characteristics and applications into the latest edition of the Technical Bulletin on this subject.

Its 12 pages are full of information never previously published in a single catalog. Presented in convenient tabular and graphic form are extensive data accumulated by Mallory's own research and by organizations who are now applying this versatile material. Among the subjects covered are—

A complete listing of physical properties
Properties at elevated temperatures . . .
expansion, fatigue, tensile properties
Radiation shielding data . . . tenth layer thickness up to 10 Mev, absorption for various isotope radiation
Permissible rotation speeds of rotor rings

Completing the publication is a discussion of the excellent corrosion resistance of Mallory 1000, and recommendations for machining and joining. Altogether, the Bulletin constitutes a valuable reference on a metal that you will be able to apply advantageously in many different products. Write to Mallory for a copy today.

USE MALLORY 1000 METAL FOR—

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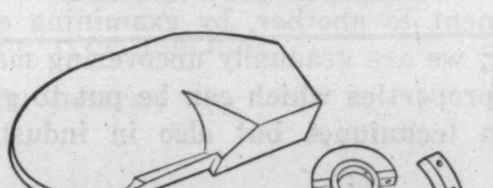
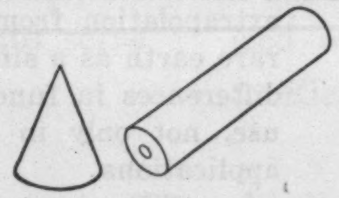
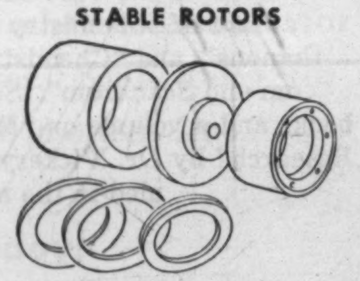


EFFICIENT RADIATION SHIELDING



STABLE ROTORS



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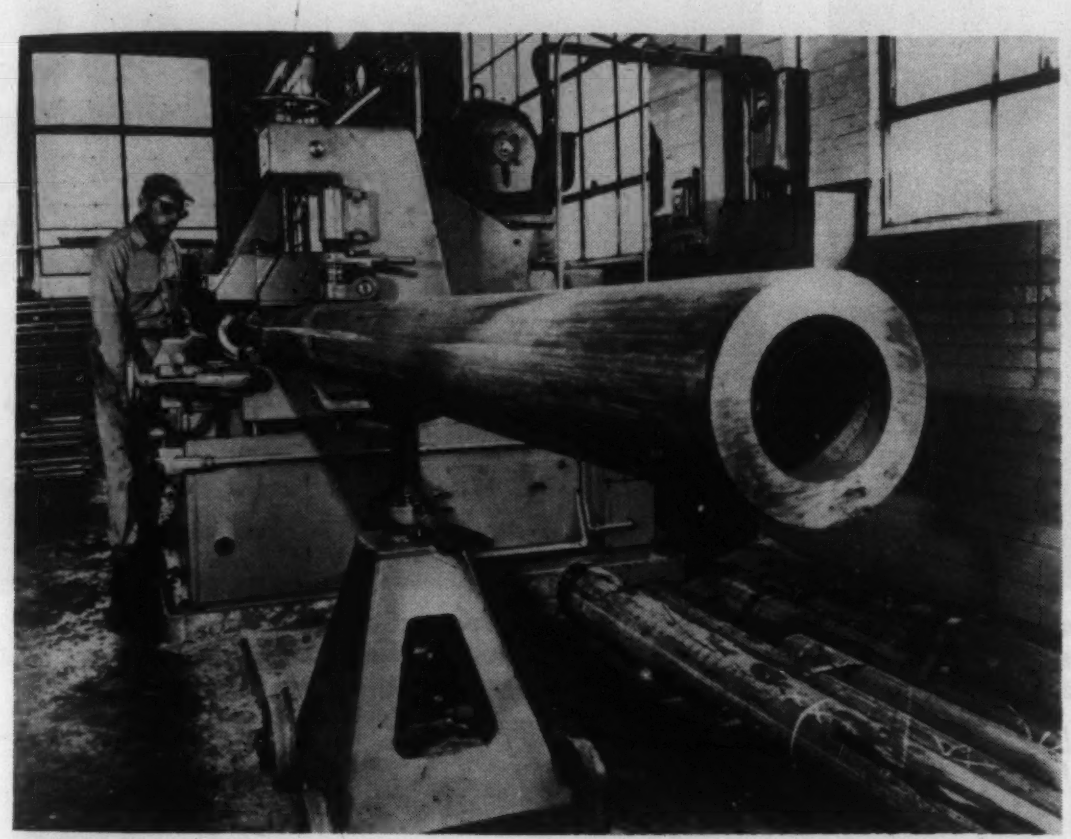
MATERIALS ENGINEERING NEWS

▸*Continuous Casting* ▸*New Research Centers* ▸*Titanium Clearing House*
▸*Materials Stockpile* ▸*Aluminum Stretcher* ▸*Superalloys* ▸*Rainbow Metal*



Continuous-cast *bearing bronze 9 in. in diameter is cut to customer length. Scrap end losses are held to a minimum.* *(American Smelting and Refining Co.)*

Continuous Cast Bronze Upped in Diameter

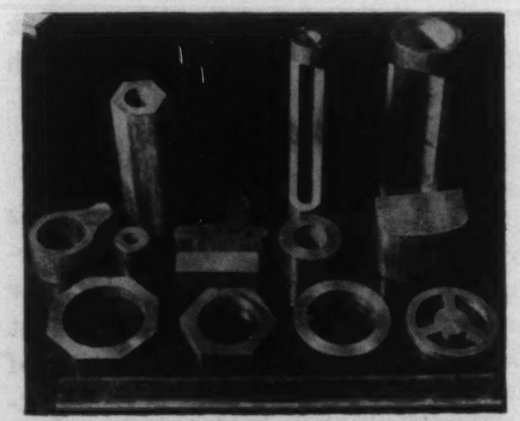
Breaking through fabricating barriers is a specialty of U. S. industry. With the announcement of 5 to 9 in. dia Asarcon 773 bearing bronze, American Smelting and Refining Co. climaxed another phase in the development of continuous casting. Previously the nature of the vertical casting units imposed severe engineering problems when large diameter castings, above 5 in., were considered. The break-through to larger sizes was eventually accomplished by design modifications in melting, casting, driving, sawing, and handling equipment.

The basic process remains unchanged. Molten bronze flows continuously into water-cooled graphite dies, freezes, and emerges cast to size in the form of finished mill lengths as long as 16 ft and in diameters ranging from 7/16 to 9 in., with shapes varying from true round to more complex, ready to use "as cast."

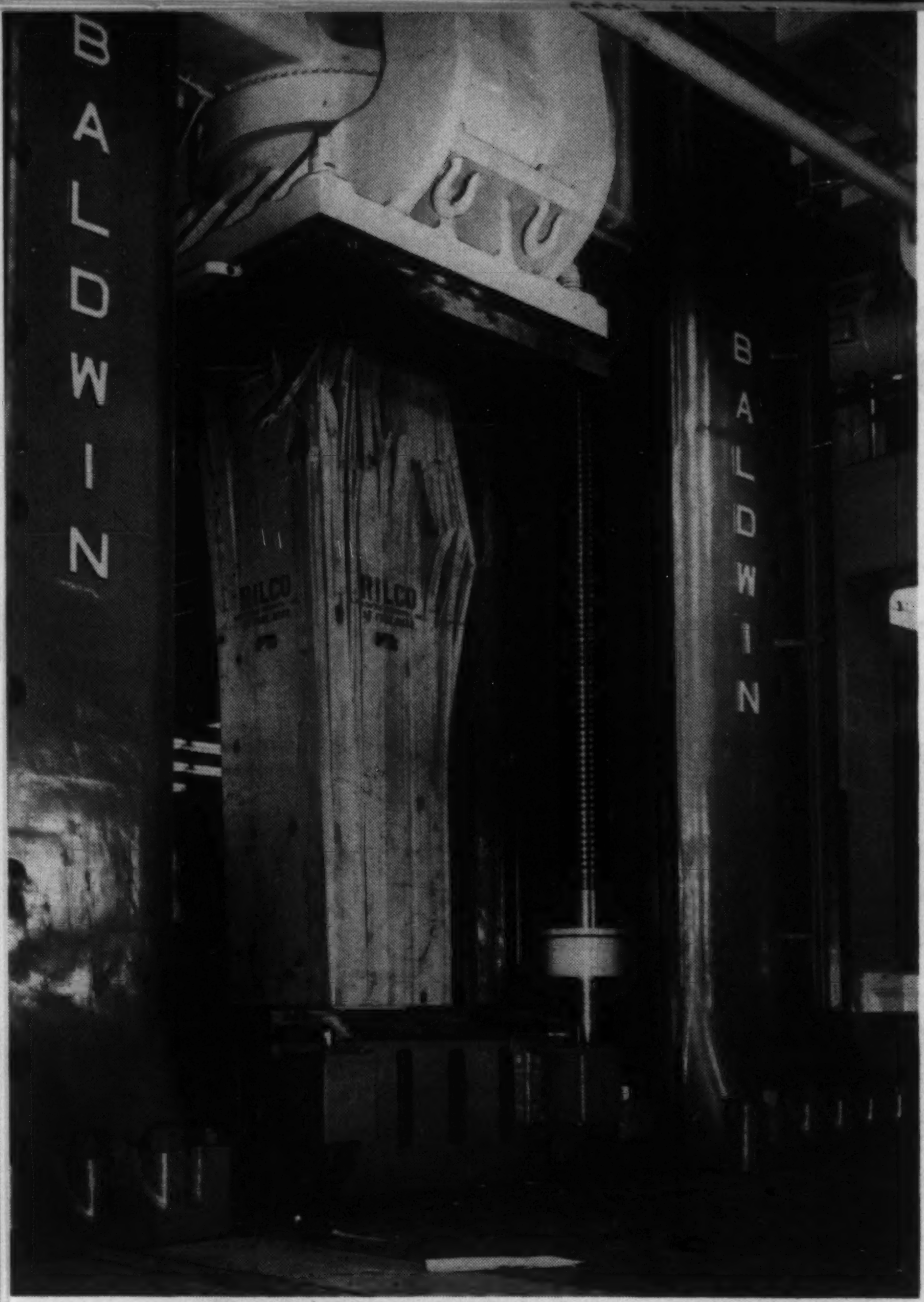
The gravity-fed bottom-flow casting method prevents the trapping of dirt and dross. Sand inclusions are non-existent in the continuous cast product. Foreign matter floats on the top of the melt without turbulence to carry it into the product. Freezing from the bottom upward permits the escape of any dissolved gases that could cause porosity.

One advantage of the continuous cast process is that a customer can get a product cut precisely to specific length requirements. A traveling saw, mounted below the driving rolls, is engaged at intervals to cut uniform lengths. There are no remnants as in the case of conventional 12 in. or 13 in. lengths.

Only a minimum of machining is necessary since each ready-to-cut length is cast with a profile approximating the shape needed. The need for specialized machinery in achieving high production rates from individually rough cast pieces is eliminated together with the uncertainties in quality frequently a problem in foundry products.



As-cast *bars, tubing, and shapes are turned out to customer specifications.*



Destruction testing. *Universal testing machine at Lehigh University's Fritz Laboratory compresses a 10 ft, 30 x 30 in. wooden structure. Max. load was 4,840,000 lb.*

Mechanical midwifery. *Utilizing a part of its 5,000,000 lb energy, the mammoth testing machine delicately cracked an egg that had been incubated for 21 days.*

New Research Laboratories Dedicated

Better materials and better applications can result only from increased research and quality control. In line with industry's continuing demand for high performance materials, two new research centers—one for Jones & Laughlin and another for Lehigh University—were recently dedicated to meet this need.

World's largest tester

In Bethlehem, Pa. the Fritz Engineering Laboratory of Lehigh University added two new sections to its facilities. Most spectacular was the installation of the world's largest universal testing machine. Designed by the Baldwin-Lima-Hamilton Corp. of Philadelphia, the machine is capable of applying both tensional and compressional loads up to 5,000,000 lb. Specimens or structures 40 ft high can be tested, an increase of 25% over the next largest testing machine of the same load capacity.

Referring to this mammoth installation in his dedication address, Dr. Allen V. Astin, Director of the National Bureau of Standards had this to say: "The new 5,000,000 lb tension and compression machine now housed in this laboratory is in itself a giant physical expression of the advances made in structural engineering during the past half century.

"It will make possible," Dr. Astin continued, "experimental studies which heretofore were not feasible. Size in such machines is an important factor in research and testing.

"With this high capacity machine there will now become available to structural engineers design information on actual tests of large structural sections. These data will eliminate much of the theoretical extrapolation of test results gathered from sample or cut specimens. Design engineers can now look forward to improved data leading to safer and more economical structures."

Graham Laboratory library, *Jones & Laughlin Steel Corp. was planned so that book capacity may be doubled in the future. Containing 3500 volumes at present, it is the largest room in the administration building.*

On the academic side, the additions will provide special laboratories for instruction, research and testing in concrete, hydraulics, materials testing, soil mechanics, and sanitary engineering.

New science center

On the banks of the Monongahela, just upstream from Pittsburgh's Golden Triangle, Jones & Laughlin Steel Corp. dedicated its new science center, "The Graham Laboratory for J&L Research." The official name of the laboratory was revealed by Admiral Ben Moreell, J&L Board Chairman, who unveiled a plaque inscribed: "The Graham Laboratory For J&L Research Named in Honor of Herbert Winfield Graham Whose long career with Jones & Laughlin is a symbol of devotion to the progress of his company, the encouragement of its scientists and engineers, and the broad development of industrial research."

Investigative programs of the Graham Laboratory cover all phases of J&L's operations from raw materials processing, iron and steelmaking, production of finished steel products, organic chemical processing, and development of new instruments for automation and quality control.

In a speech delivered during the dedication, Howard S. Turner, Vice President—Research and Development, made these observations, "From the standpoint of research management, it is a waste of time and money to be constantly successful in a laboratory. That is the area in which we should exhaust what can be learned from failures in the cheapest and quickest way and reserve success for ourselves in

(Continued on p. 228)

Titanium Information Available

A titanium service organization has been established at Battelle Memorial Institute by the Federal Government to act as a clearing house for information on the metal.

Known as the Titanium Metalurgical Laboratory, this organization has three major functions: 1) acting in an advisory capacity to government agencies, 2) supplying advisory services for contractors under the government titanium program, and in certain cases for others, and 3) collecting and disseminating information on titanium technology.

Literature survey

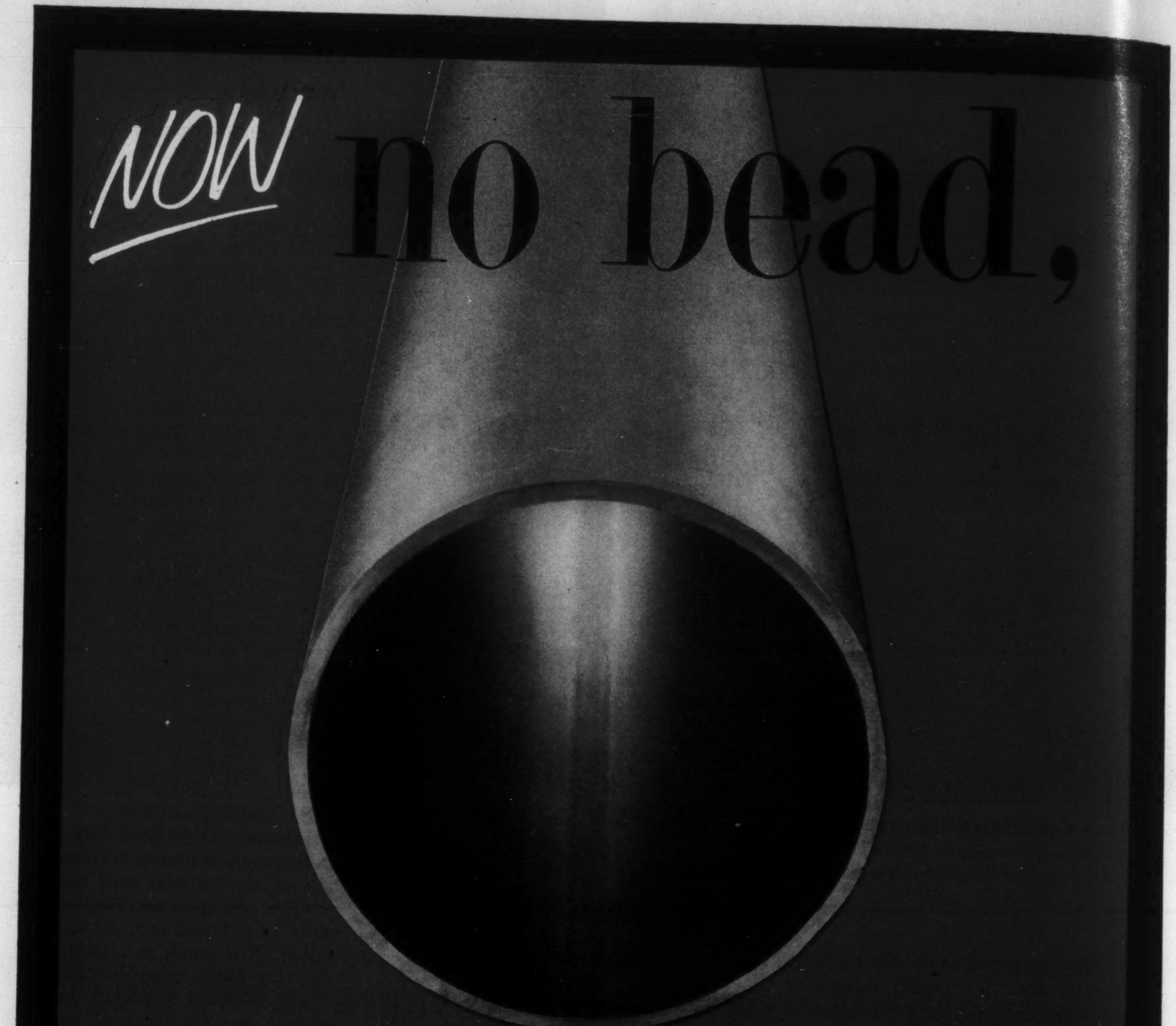
Of major interest to engineers not engaged in government programs is the third function. The Laboratory is collecting information on titanium from all possible sources. Thus far, these have included reports from over 600 government projects, a search of world-wide scientific literature and of world patent literature.

Information obtained from these sources is studied by members of the Battelle staff and extracts are made and filed on cards by technical subjects and author. The result is a multiple-entry file so complete that it is unnecessary to consult the original paper because all essential information is carried on the card.

Available without cost

Although the Titanium Metallurgical Laboratory services are designed primarily for defense contractors and Government agencies, they are also available, within liberal limits without cost, to all those who have a direct interest in titanium technology.

Summarizing reports on portions of titanium technology is prepared on a scheduled basis. These state-of-the-art reports —about ten have appeared to date—are distributed to a large mailing list. Requests for information should be addressed to: Titanium Metallurgical Laboratory, Battelle Memorial Institute, 505 King Avenue, Columbus, Ohio.


NOW
no bead,
Photograph of Contour-Welded 3" I P S Schedule 10 pipe Type 304
CONTOUR-WELD PIPE...BEST BY ANY TEST YOU CAN NAME
Reverse Bend
(2⅜" O.D. x .154 wall)
Uniformity
Flare and Flange
Flattening
Pressure (Tubing)

Reynolds

ALUMINUM REPORTER

★ ★ ★ Twentieth in a Series to Industry on Aluminum Uses and Developments ★ ★ ★

ALUMINUM EXTRUSION SOLVES SCRAP PROBLEM

Aluminum's Easy Machinability Ideal for Short-Run Production of DoALL Monolight

DoALL Monolights are used to check the accuracy and measure the finish of gauges and lapped parts to within millionths of an inch. These generators produce Monochromatic light of a single, known wavelength which enables operators to detect incredibly small surface irregularities by observing reflection patterns.

New DoALL 2" utility Monolight. Non-magnetic aluminum permits use on magnetic chucks.

These precision instruments are produced in short-run quantities. These limited production runs make cast and machined aluminum the most economical material to use, cheaper than stamping or sheet metal fabrication. Finishing operations, too, are easier, and trim is given its shiny appearance simply by buffing. Other aluminum advantages, light weight combined with great strength, are important factors, as Monolights are used at work benches, and in regular inspection procedures they are frequently moved from place to place. DoALL Monolights vary in size from 2" to 20". The 2" instrument is often used on magnetic chucks of surface grinders to check surface finishes. Here aluminum provides complete magnetic shielding for the Monolight's transformer. Life of the Monolight instruments is longer because of aluminum's non-rusting and corrosion resisting characteristics.

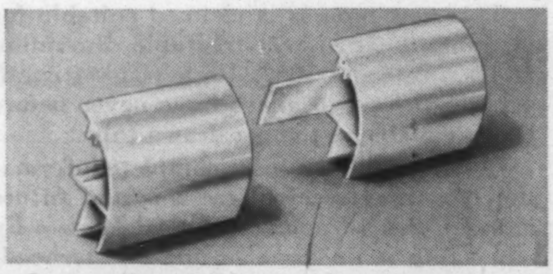
The aluminum advantages considered by DoALL, plus its excellent heat and light reflectivity, high electrical and thermal conductivity indicate aluminum's use in a broad variety of applications.

For applications in which the easy machinability of aluminum is a consideration Reynolds offers a special technical handbook, "Machining Aluminum Alloys." This 124-page book covers tools, speeds and feeds, plus information on operations including automatic screw machining. Single copies of "Machining Aluminum Alloys" are free when requested on your business letterhead. See address below.

A. A. F. Uses Aluminum in Filter, Fan, Coil, Grille, Duct and Damper of Classroom Unit Ventilator

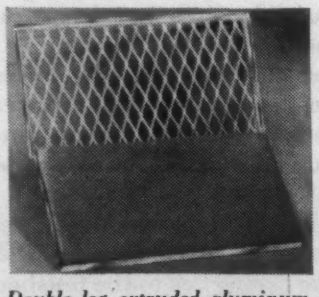
The ability of aluminum extrusions to economically provide intricate cross-sections to close dimensions solved a problem and supplied a fabricating advantage to American Air Filter Company of Louisville, Kentucky.

The problem solved by extrusions involved the moulding along the top of the multi-unit Herman Nelson Classroom Unit Ventilator, shown at right. This piece was formerly rolled from steel and had to be folded down at each end to provide for fastening adjacent units. Bending frequently resulted in wrinkling and wrinkled pieces had to be scrapped.



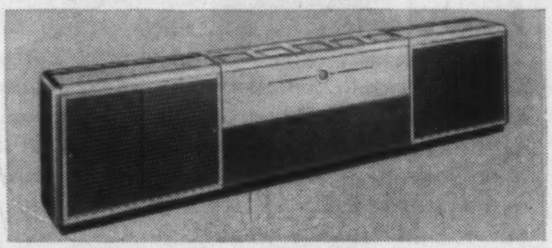
Scrap problem solved by extruded moulding with track for short locking strip, set screws.

Redesigning the moulding to a 6063-T42 aluminum extrusion offered a simple joining solution by including a locking strip track. As shown below, an aluminum locking strip is inserted in the track, at the ends of adjacent moulding sections. The strip is then secured by a screw in the lower track of each moulding. Only an extrusion could make this track possible in the intricate cross section of a single piece moulding. And the dimensional accuracy of Reynolds Aluminum extrusions provided perfect alignment of the butted ends resulting in a clean, accurate, strong joint at a lower cost than ever before.



Double leg extruded aluminum angle frames retainer for removable glass filter.

A renewable air filter with a lightweight aluminum frame and face was developed as a low maintenance feature of the same classroom unit ventilator. The frame is extruded, 6063-T4 aluminum angle with a double leg on one side. After notching, the angle for each of the two frame elements, is formed around a 1½" mesh, expanded, flattened aluminum face sheet, so that the sheet fits into the channel formed by the twin legs of the angle. Frame corners are heliarc welded; face is tack welded to the angle; and the two frame halves joined by spot welded hinges.



Classroom unit ventilator with extruded aluminum moulding across top, front edge.

Aluminum simplifies balancing of squirrel cage fan, prevents moist air rust.

Since the air intake grilles and ducts, and the squirrel cage fans of the classroom ventilator frequently handle damp, outside air, Reynolds Aluminum's rustproof quality is of special value in these applications. In addition, the light weight of aluminum greatly simplifies and reduces the cost of balancing the fans, and makes airstream actuation of a recirculating damper most efficient. Fan center disc, rims and blades are all made of 3003 aluminum alloy in H16, H14 and H18 tempers respectively, and the hub is 2011-T3 aluminum screw machine stock. Assembly is by upsetting blade ends against rims, center disc against blades, and hub against center disc. Duct, grille, and damper are all formed from 1100-H16 aluminum sheet.

Because of the heat transfer efficiency of aluminum and its extremely favorable price and supply advantage over copper, fins for heating coils in the classroom unit ventilator are made of 1100 alloy aluminum in the 0 temper.

To improve your products with aluminum, Reynolds Styling and Design departments will be glad to work with your engineers. As American Air Filter has with their application of aluminum, you may be able to increase efficiency and sales appeal without increasing cost.

Reynolds has prepared a 138-page handbook, "Designing with Aluminum Extrusions." Single copies are free when requested on business letterhead. Also available is a complete index of Reynolds technical literature and films. See address below.

WRITE REYNOLDS METALS COMPANY, P. O. BOX 1800-HM, LOUISVILLE 1, KENTUCKY

MORE INTERESTING NEWS ABOUT ALUMINUM ON NEXT PAGE

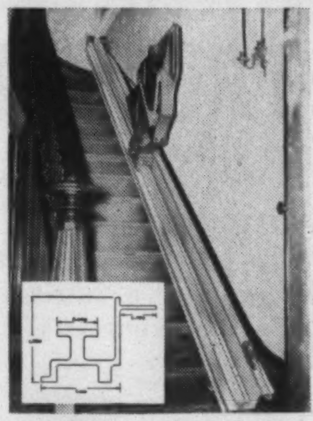
(Advertisement)

Printed in U.S.A

(Continued From Preceding Page)

Single Aluminum Extrusion Replaces 3 Element Assembly in Sedgwick Elevators

Sedgwick Machine Works of Poughkeepsie, N. Y., recently switched to one of the largest aluminum extrusions produced for commercial use, for the rail on which its Stair-Traveler home elevator operates.



Previously, Sedgwick used a heavy metal rail assembled from a standard 5″ x 5″ x 3/8″ hot rolled angle and two pieces of cold rolled bar stock. One piece of bar stock was 1″ x 1¾″, and for the top of a Tee, a ½″ x 3″ piece was used. These pieces had to be laid out, machined and welded.

By using the aluminum extrusion illustrated, Sedgwick simplified layout and eliminated welding and machining costs as well as the cost of combining sections to make one long rail. In addition, desirable new features included in the extrusion were not feasible in the welded assembly. And corrosion, which had occurred when the part was made of ferrous metal, has been eliminated completely.

Extruded aluminum, means a considerable per foot saving in manufacturing and installation costs, and customers save on F.O.B. freight charges due to aluminum's light weight.

Many companies are now using aluminum extrusions to reduce their costs. To acquaint you with their possibilities and low cost of dies, Reynolds offers a 138-page handbook, "Designing with Aluminum Extrusions." Single copies free when requested on business letterhead. See address below.

New Method For Making Aluminum Tube From Strip

Reynolds Metals "Technical Advisor" No. 29, details a new low-cost method for making aluminum tube directly from strip. A fabricator can make his own tube in his own plant and obtain many important economies. The new method is claimed to greatly extend applications of aluminum tube, as it easily handles diameters from ½″ to 2¼″ and wall thicknesses from 0.020″ to 0.083″.

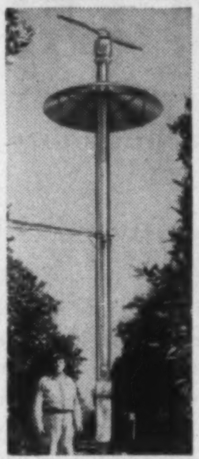
In this method, strip is formed into a tube by a series of forming rolls. Tube then passes through a welding head where high-frequency current (450,000 cycles) is focused to heat by electric induction only the very edge of the strip at the exact point where the edges are butted together. No metal is added. Other rolls now squeeze out the melted metal, leaving only an extremely narrow weld zone. This eliminates weak cast metal so the weld zone has strength equal to that of unwelded tube. The weld is made at a rate of 100 feet per minute or more. The weld is exceptionally strong.

This new process is claimed suitable for working the non-heat-treatable aluminum alloys, 5050 and 5052. High yield-strength tube in these two alloys have never before been available as temper drawn tube.

If you would like more complete information you may receive free this and future issues of the Reynolds Technical Advisor by requesting it on your business letterhead. See address below.

Stationary Whirlybird Drives Away Smog, Fog and Frost

The odd-looking structure pictured below owes its existence almost entirely to the unique properties of aluminum. It is the "Weather-Master" fog and frost control tower, manufactured by Diesel Power Inc., Greenville, Pennsylvania.



Operating on the helicopter principle, the Weather-Master pulls warm, dry upper air down against an adjustable diffuser and spreads it evenly in all directions. A special, horizontal propellor is driven by a vertically mounted electric motor.

Each tower replaces several of the smudge pots now used to protect fruit and tender plants against frost. They also relieve fog conditions at airports. There are 20 agricultural applications and industrial uses.

Because the Weather-Master stands 30 feet high, it must be constructed of a metal that is both strong and light. Light weight is also an advantage in shipping and erection. The moist air the Weather-Master is designed to dispel cannot rust aluminum. Painting is never necessary.

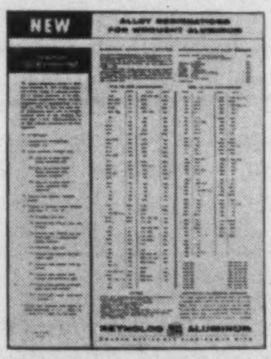
The tower is a 10″ od extruded tube with a .188″ wall of 6061-T6 aluminum. Other structural members are 6061-T6 aluminum angles. Diffuser is 3003-H14 aluminum sheet. Base and motor mountings are aluminum castings.

If aluminum can benefit your products, Reynolds engineers will be glad to assist you on design or redesign. Or write for the 130-page handbook, "Aluminum Structural Design." Free when requested on business letterhead. See address below.

WHAT'S NEW A Quick Look at New Reynolds Aluminum Products and Applications

Wrought Aluminum Alloy Designation Chart Available

A special chart is available from Reynolds Metals Company, showing old and new alloy designations for wrought aluminum. The new designations are those put into effect by the Aluminum Association on October 1, 1954.



The Reynolds chart is in two sections—old to new conversion, and new to old conversion. In addition it is footnoted with both general and specific data. A review of the Temper Designations system in effect since 1947 is also included.

For copies of this convenient chart in 8½″ x 11″ and 17″ x 22″ sizes, write to Reynolds Metals Company at the address below.

Reynolds Offers New R-2003 Calcined Alumina

Calcined alumina of top ceramic quality at regular commercial prices has been announced by Reynolds Metals Company.

R-2003 calcined alumina contains fewer impurities and less water, which reduces dusting and minimizes shrinking. It contains only traces of such impurities as oxides of iron, silicon and titanium.

The new calcined alumina is highly resistant to thermal and mechanical shock, and transmits these properties to the finished product. Applications of R-2003 alumina range from abrasives to use in refractories for lining tanks or furnaces. For further information, write to Reynolds at the address below.

Reynolds Aluminum Foil Finds New Packaging Application

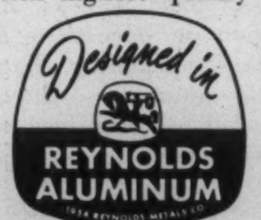
Added to the countless food packaging uses for Reynolds Aluminum foil is a new foil-paper material for multiwall bags for bulk packaging of hygroscopic chemicals, resins, or other products requiring high moisture protection.

One company is using 50-pound foil lined bags for packaging its animal feed, and Reynolds is using a 100 pound bag for packaging and shipping activated alumina.

Names of foil lined bag manufacturers are available on request.

Consumers Look For Reynolds Design Seal

This "Designed in Reynolds Aluminum" seal is familiar to millions of homes, thanks to extensive television advertising. To consumers it means products manufactured with highest quality aluminum — makes buyers out of shoppers. For details on how your company can qualify for this seal, write Reynolds Metals Company at the address below.



FOR COMPLETE INFORMATION ON THESE OR ANY OTHER REYNOLDS ALUMINUM PRODUCTS, write to Reynolds Metals Company, P.O. Box 1800-HM, Louisville 1, Kentucky

For more information, turn to Reader Service Card, Circle No. 482

THE RIGHT MATERIALS
THE RIGHT CAPACITIES
THE RIGHT ECONOMIES

for your specific needs

BRONZE

BRASS

IRON

STAINLESS STEEL

ALLOY STEEL

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and other grades and alloys

IN

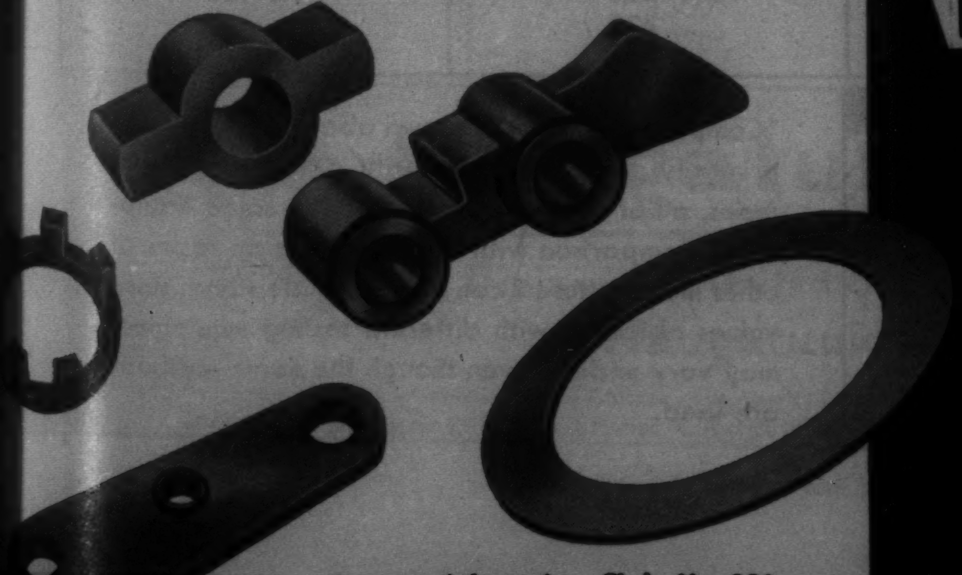
POWDERED METAL PARTS

by Keystone

Name your application: heavy-duty structural parts, pieces that must resist corrosion or heat, bearings with built-in lubrication, porous metal filters or many another item—*we'll* produce the right answers for you in material, volume and price. Send us your requirements, for prompt analysis and quotation.

Keystone
CARBON
COMPANY
POWDERED METAL DIVISION
ST. MARYS, PA.

Write for this informative Bulletin B-54, detailing composition and properties of popular Keystone powdered metal grades.



For more information, Circle No. 356

3 *New* MARVINOL RESINS

broaden your choice of PVC processing qualities

	MARVINOL VR-10	MARVINOL VR-20	MARVINOL VR-21
Description	General Purpose.	Film Calendering.	Cold, dry premix for calendering film and sheeting.
Special Features	Highest molecular weight. Low deformation at highest temperatures. Very fast mill or Banbury mixing. Good for foaming and dispersion applications. Good for blown extruded film. High speed extrusion.	Medium molecular weight. Recommended primarily for calendered film. Behaves well in hot or cold premixes. High bulk density for large Banbury charges.	High molecular weight, cold, dry premixing resin. Leaves mixers clean, minimizing color changeover problem. Recommended primarily for calendering film, sheeting and coated fabrics.
Resin Properties			
Specific Viscosity	0.52	0.38	0.44
Average Apparent Density, lbs/cu. ft.	26	32	22
Average Particle Size, microns	6	32	11
Acetone Solubility	20	37	31
Specific Gravity	1.40	1.40	1.40
Compound Properties* **(100 parts resin, 50 parts DOP)**			
Shore "A" Hardness	82	78	80
Tensile Strength, psi	2900	2600	2800
Ultimate Elongation, %	340	360	360
100% Modulus, psi	1475	1300	1425
Tear Strength, lbs/in.	480	430	460

MARVINOL DATA REQUEST FORM

NAUGATUCK CHEMICAL,
Div. United States Rubber Company, Naugatuck, Conn.
Please send Technical Data on Marvinol resins checked at right.

Name........................Title.............
Company....................................
Address....................................
City................Zone.....State.........

☐ VR-10
☐ VR-20
☐ VR-21
☐ VR-22
☐ VR-24
☐ VR-30
☐ VR-50

☐ *Do* (☐ *Do not*) have your Technical Representative call on me. MM

*Compound properties shown above are intended primarily for comparison with other Naugatuck resins, all of which are tested on the same equipment. Comparison with similar figures on resins of other manufacturers can be very misleading, since values obtained with different testing equipment may vary widely, even though the same methods are used.

HERE'S the current family of MARVINOL vinyls, industry's most complete line of straight polyvinyl chloride resins! Whatever your processing equipment . . . whatever your end product, there's a MARVINOL resin ideally suited to your needs!

For instance, do you want an easy-processing calendering resin designed especially to permit lower temperature operation? Then choose the new MARVINOL VR-24. If you're looking for a dispersion resin that readily stirs into plasticizers, there's the new MARVINOL VR-50. If it's a good electrical grade resin you need, MARVINOL VR-22 is approved by Underwriters' Laboratories, Inc.

Faster calendering? Larger Banbury charges? Easier dry blending? Choose the right MARVINOL® resin and they are yours!

May we send you Technical Data Sheets on any of these outstanding PVC resins? There's a form below for your convenience.

MARVINOL VR-22	New MARVINOL VR-24	New MARVINOL VR-30	New MARVINOL VR-50
Electrical Grade. Hot, dry blend for extrusion.	Easy processing and calendering.	Cold, dry premix for coated fabrics, film, sheeting and calendering.	Paste Dispersions.
High molecular weight with high bulk density for large Banbury charges. Excellent hot, dry blending properties for extruder feed; reduces mixing cycles. Approved by Underwriters' Laboratories, Inc. for electrical applications.	Low molecular weight with high bulk density, designed for low temperature calendering. Can be hot dry-blended. Can be used in semi-rigid compounds.	Medium molecular weight, low bulk density. Minimizes mixer clean-out problems. Mills and Banburys rapidly. Particularly good for most phases of calendering: film, inflatables, sheeting and coated fabrics. May be heat sealed. Excellent for injection molding.	Stirs into plasticizers readily to form pastes of good shelf life and excellent viscosity characteristics, for cloth-coating, dipping, slush molding, film casting, spraying and rotational molding. Makes excellent organosols.
0.44	0.30	0.38	0.50-0.52
27	33	21	15-19
22	25	15	—
25	51	46	—
1.40	1.40	1.40	1.40
80	77	78	*Physical Properties* 6 mil Film, 380° F. (100 parts VR-50, 66.6 parts DOP)
2800	2200	2800	
340	270	350	Tensile, psi 2700
1500	1300	1450	Elongation, % 280
450	370	410	100% Modulus, psi 1300

Naugatuck Chemical

NAUGATUCK

Division of United States Rubber Company
Naugatuck, Connecticut

US RUBBER

BRANCHES: Akron • Boston • Gastonia, N.C. • Chicago • Los Angeles • Memphis • New York • Philadelphia • IN CANADA: Naugatuck Chemicals, Elmira, Ontario
Rubber Chemicals • Synthetic Rubber • Plastics • Agricultural Chemicals • Reclaimed Rubber • Latices • Cable Address: Rubexport, N. Y.

For more information, turn to Reader Service Card, Circle No. 354

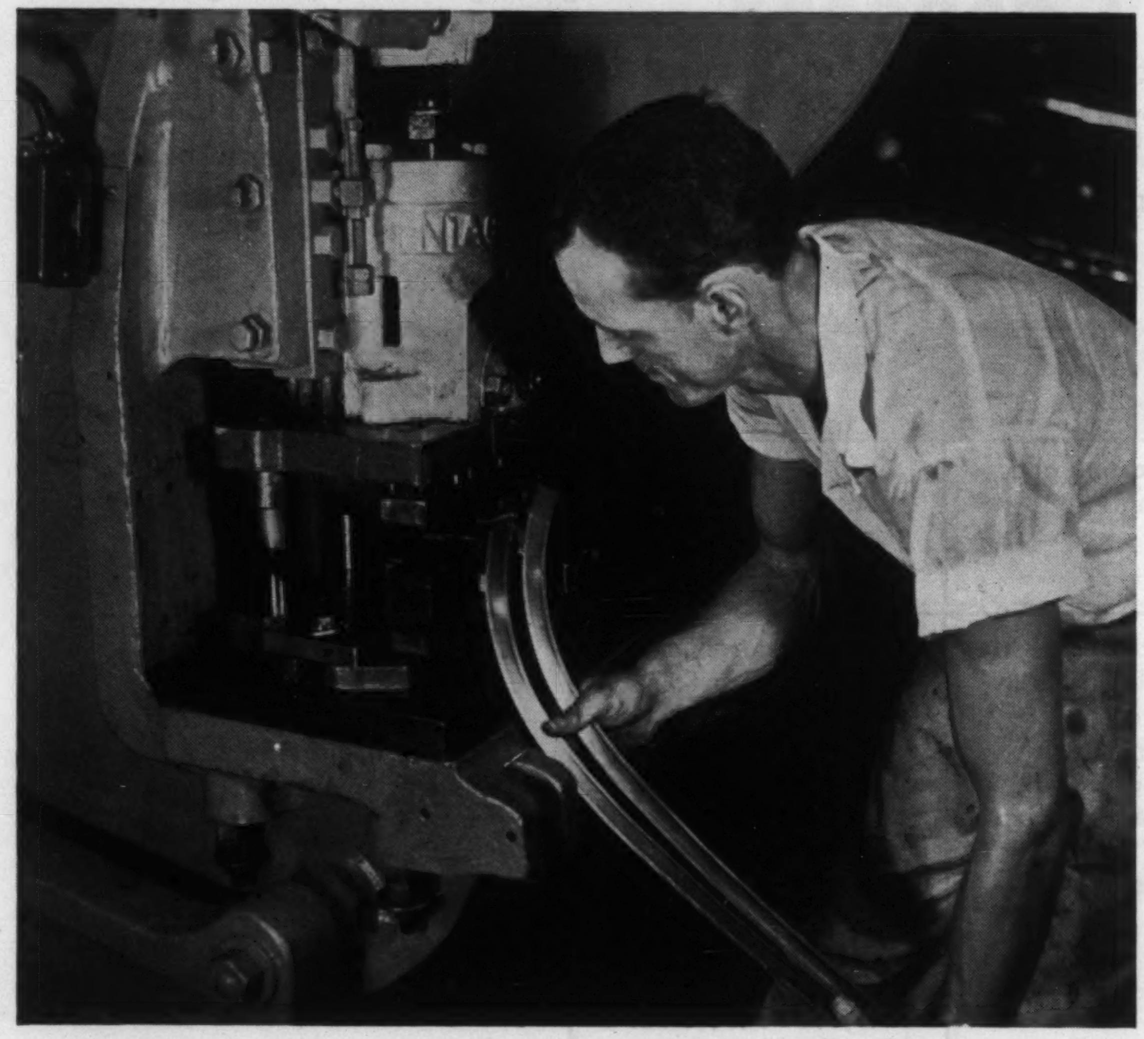
Tool Steel Topics

BETHLEHEM STEEL

On the Pacific Coast Bethlehem products are sold
by Bethlehem Pacific Coast Steel Corporation

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Export Distributor:
Bethlehem Steel Export Corpora



Notching Die Made of Bearcat Gives 7 Times Greater Output

An interesting item being manufactured in the southeastern part of the country is a windshield garnish molding for a popular make of automobile. The molding is produced from cold-rolled steel, 0.020 in. thick. It is formed by a notching die, hardened to Rockwell C 56-58.

With the grades of shock-resisting tool steel formerly used for the die, a maximum of 1400 pieces was produced before breakage occurred. Because of the severity of the application, this was considered good production even though it necessitated a change of die about five times daily.

After studying the operation, we suggested a change to Bearcat tool steel. "Bearcat is a super shock-resisting grade," we said. "We're sure it will last longer in a tough job like this, and so save you money. Why don't you give it a try?"

So Bearcat was put to work. The dies made of Bearcat have been giving a good account of themselves by producing up to 10,000 pieces before being replaced. That's seven times the output obtained from the dies before changing to Bearcat.

Surprising? Not at all. Bearcat is continually chalking up new performance records in a variety of interesting applications. Bearcat is a superior, general-purpose grade of air-hardening tool steel. It has exceptional resistance to shock, and is also well suited for uses where hot-work properties and easy machining are essential. Bearcat can be used in a wide range of applications such as punches, master hobs, engraving dies, and short-run dies used in cold-forming, blanking and bending.

The best way to determine how good a job Bearcat can do is to put it to work on some difficult job in your shop. You can order Bearcat through your local Bethlehem tool-steel distributor. We also carry it in stock in our mill depot.

BETHLEHEM TOOL STEEL ENGINEER SAYS:

Retemper Tools After Grinding

No matter how carefully performed, grinding operations on hardened tools always generate residual stresses in the tools. But as tools already contain residual stresses after they are quenched, any additional stresses are likely to cause trouble. Now, if the combined stresses are sufficiently high, cracking may occur during grinding, which makes it easy to locate the source of the trouble. But if the combined residual stresses are just below the ultimate strength of the steel, cracks will not appear for the time being. Instead, the tools are apt to crack subsequently, at the application of normal stresses set up either in handling, or in using the tools.

To avoid this difficulty, we recommend reducing the stresses to a safe level by retempering the tools immediately after grinding, using a temperature which is slightly lower than the original tempering temperature. With many toolmakers, retempering after grinding is routine procedure, a form of insurance, more or less, against running into trouble.

BLANKING DIE FOR HANDBAG HANDLES

This blanking die, used by Westberg Tool and Manufacturing Company, Bridgeport, Conn., for the manufacture of handbag handles, has BTR (Bethlehem Tool Room) tool steel in both the die and the punch. BTR is our long-wearing, general-purpose, manganese-chromium-tungsten grade of oil-hardening tool steel.

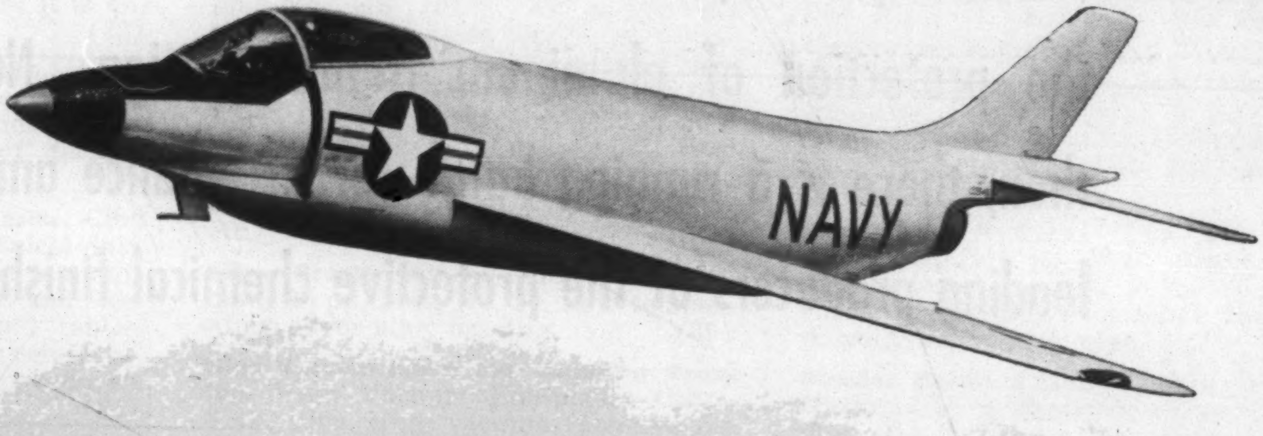
For more information, turn to Reader Service Card, Circle No. 428

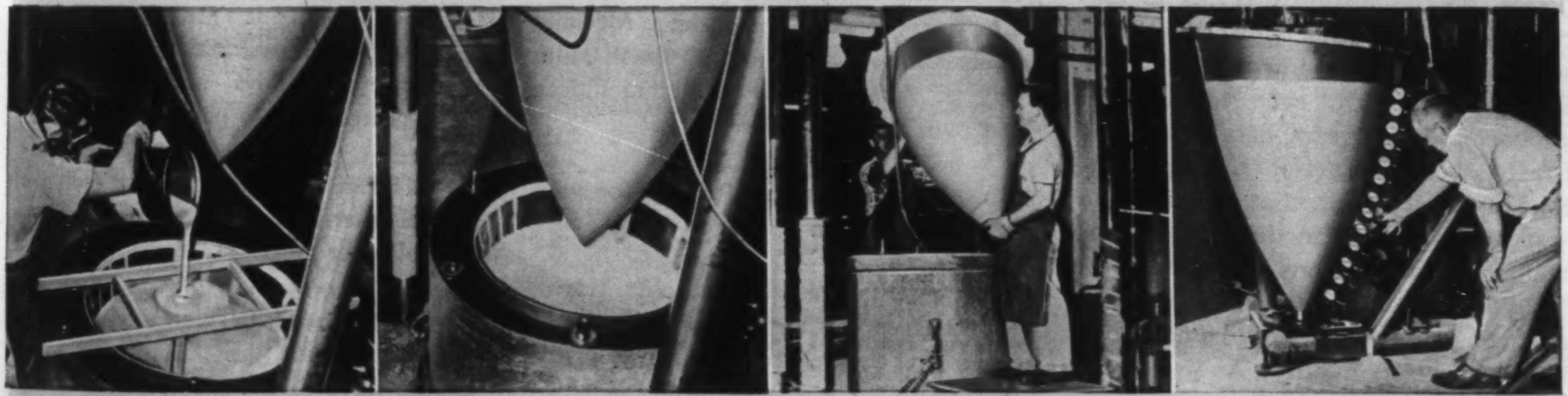
"We use

NOPCO® LOCKFOAM for the radome because it is uniform, offers better electrical properties, and permits closer dimensional tolerances"

says **THE BRUNSWICK-BALKE-COLLENDER CO.**

U. S. NAVY'S F3H-2N ALL-WEATHER "DEMON" single-jet, carrier-based fighter plane made by McDonnell Aircraft Corp., St. Louis, Mo. The "Demon" is an all-weather, high performance fighter combining interceptor speed and fighter maneuverability with the payload of an attack bomber. It utilizes the latest in electronic aiming devices. The high precision radome—one of the largest in commercial production—is made for McDonnell by The Brunswick-Balke-Collender Co., Plastics Division, Marion, Va.





Sequence of photographs showing Nopco Lockfoam being poured into the mould—where it solidifies in a matter of minutes—removed as the finished radome, and inspected. These show some of the reasons for Brunswick's statement that with Lockfoam they have been able to reduce the man-hours needed.

Where you find the most modern in construction, you are very apt to find Nopco Lockfoam being used. And that goes not only for aviation and electronics manufacture, but in many other industries as well. Airplane radomes are but one of the first conspicuous applications which are using to good purpose Lockfoam's excellent electrical properties, its strength-weight ratios, plus Lockfoam's ability to fill exactly the configurations of any cavity into which it is poured.

Nopco's technical staff will cooperate with you to the fullest. Write today for the Nopco Lockfoam booklet. Nopco Chemical Company, 300 Stier St., Harrison, N. J.

NOPCO

PLASTICS DIVISION
HARRISON, NEW JERSEY
Los Angeles, Calif.

For more information, turn to Reader Service Card, Circle No. 371

Advertisement

A SPECIAL REPORT ON PROTECTIVE FINISHES FOR ALUMINUM

Most aluminum producers and fabricators are well aware of the superiority of chemical finishes over anodizing for the protection of aluminum from corrosion. Naturally, then, there is a running battle for acceptance among the leading producers of the protective chemical finishes.

That's why, here at Allied, we have always studied your needs with regard to both our own and competitive processes. We're constantly trying to produce new and better finishes because we believe there's always room for improvement . . . even to our own products. Some years ago this policy led to the introduction of a process, long in development, that offered you a way to overcome anodizing's obvious technical complications . . . Iridite #14. This finish was far easier to use than anodizing, yet provided comparable, if not superior, quality. And, its cost was much less than anodizing.

But other finishes offering similar advantages over anodizing have entered the market. So . . . the current battle for acceptance. By any cost comparison Iridite #14 is the most economical. However, corrosion tests by users show contradictory results as to performance from Iridite #14 and other leading protective finishes for aluminum. Most tests show Iridite #14 superior, but some do not. The margin of difference, however, is always small. The truth is that all have proved good. However, our laboratory research indicated that still further improvements could be made.

That knowledge . . . plus our aim to give you even better protection and maintain the leadership of the industry, is exactly why Allied Development Engineers have been working for long years to develop a better finish than any of those now available, including our own Iridite #14.

Now the new finish is ready for you. It's called Iridite #14-2 (Al-Coat).

From a performance standpoint, Iridite #14-2 gives you two important advantages in the protective finishing of aluminum.

FIRST: in its fully colored brown film stage it provides corrosion resistance decidedly superior to previous processes.

SECOND: the basic brown film can be hot water bleached to produce a clear-type film with protection heretofore unobtainable from clear-type chemical finishes.

From an operating standpoint, new Iridite #14-2 gives you three important advantages.

FIRST: it provides consistently higher corrosion resistance for different aluminum alloys treated in the same bath.

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THIRD: its operating and technical characteristics are superior to those of other processes.

If you are using or planning to use a chemical finish for aluminum, you should have full details on new Iridite #14-2. Write us or send samples for free test processing. Or, for more immediate advice, call your Iridite Field Engineer. He's listed under "Plating Supplies" in your classified telephone book. - - - ALLIED RESEARCH PRODUCTS, INC., 4004-06 EAST MONUMENT STREET, BALTIMORE 5, MARYLAND.

P. S. Even new Iridite #14-2 will be constantly measured against both your needs and competitive processes to make sure you get the best possible, most economical finish for your product that man and the laboratory can develop.

For more information, turn to Reader Service Card, Circle No. 305

Mechanical Tubing. Babcock & Wilcox Co., 4 pp, No. TB-360. Advantages of alloy steel tubing. (19)

Alminum Alloy Castings. Morris Bean & Co., 4 pp, illus. Description, history, advantages, limitations and pattern making facilities for the Antioch process aluminum alloy castings that meet exacting fluid flow specifications. (71)

Magnesium and Aluminum Alloy Castings. Bendix Foundries, 4 pp. Facilities for sand, die, shell, plaster and permanent mold castings of magnesium or aluminum. (20)

High Temperature Castable Cements. Carborundum Co., 4 pp. Data sheets for three castable cements, including properties, instructions for preparation and use, suggested usages and precautions. (21)

Decorator Flock. Cellusuede Products, Inc., 10 pp, illus. Describes flock, what it is, how it is used, and how it is applied. (22)

Chromizing. Chromalloy Corp., 4 pp, illus. Applications of surface alloying technique for increasing heat, wear and corrosion resistance of ferrous metals. (23)

Contact Pressure Laminating Resins. Ciba Co., Inc.. 17 pp, No. 1. Technical data on Araldite^R contact pressure laminating resins. Includes technical and electrical properties, charts and tables, mold preparation, glass fiber reinforcement, and manufacturing procedures. (24)

Carbon and Alloy Steel Tubing. Ohio Seamless Tube Div., Copperweld Steel Co., 8 pp. Describes four major classifications of carbon and alloy steel tubing; mechanical, pressure, airframe, and aircraft mechanical. Covers both seamless and electric resistance welded tubing, as well as tube fabricating and forging. (25)

Wet-Blast Equipment. Cro-Plate Co., Inc., 20 pp. Pressure blast abrasive, supply information and six application bulletins. (26)

Stainless Steel Fabrication. Crucible Steel Co. of America, 160 pp. Fabricator's handbook for Rezistal stainless steels. Forming, machining, cutting, joining, heat treating, pickling, finishing, and reference data. (27)

Nondestructive Testing Equipment. J. W. Dice Co., 1 p. Advantages and principle of operation of the model CE Cyclograph for nondestructive sorting of metal mix-ups. (28)

Die Castings. Dollin Corp., 16 pp, illus. Booklet describes plant and facilities for die castings. (29)

Projection Gaging. Eastman Kodak Co., 12 pp, illus. Describes four models of the contour projector and their accessories for inspection usage. (30)

Felt. The Felters Co., 22 pp. Design properties, selection and applications of felt and felt products. (31)

Friction or Damper Parts. World Bestos, Div. of Firestone Tire & Rubber Co., 4 pp, illus. Available molded parts—brake lining and blocks, transmission linings, clutch facings, thrust washers, etc. (32)

Corrosion Resistant Materials. General Ceramics Corp., 15 pp, illus. Properties and characteristics of porcelain, stoneware, coatings, graphite and alumina with high resistance to corrosion. (33)

Heat Seal Coatings and Adhesives. General Mills, Inc., 7 pp, No. 11-3-1. Formulations and applications, properties, typical formulas and melting temperature charts for Polyamide resins 94, 90 and 100. (34)

Sheet Metals. Geuder, Paeshke & Frey Co. Illustrates many completed jobs and gives information on facilities for stamped or drawn metal products. (35)

Asbestos Sheet Packing. B. F. Goodrich Co., 4 pp. New data sheet on line of compressed asbestos sheet packing includes specifications and uses of 11 grades of sheet. (36)

Graphite. Graphite Specialties Corp., 4 pp, No. GS 101-1. An impervious graphite, more than 99.5% pure carbon for high temperature parts. Chemical resistance data and physical properties including heat effects to 5700 F are charted. (37)

Packings. Greene, Tweed & Co., 30 pp. Molded packings for bearings, pistons, etc. (38)

Silver Brazing Alloys. Handy & Harman, 26 pp, illus, No. 20. Low temperature silver alloy brazing. (39)

High Vacuum Annealing, Sintering, Brazing. High Vacuum Equipment Corp., 8 pp, illus. High vacuum furnaces for pilot and production operations for outgassing, annealing, brazing, melting and sintering high performance metals and alloys such as titanium, zirconium and superalloys at high temperatures and less-than-micron pressures. (40)

Heat Treating. Holcroft & Co., 12 pp, illus. Information on various forms of Holcroft furnaces and the jobs they do. (41)

Electrical Insulation. Irvington Varnish & Insulator Div., Minnesota Mining & Mfg. Co., Irvington, N. J. Loose-leaf binder catalog of flexible electrical insulation materials — coated products, varnishes and plastic products. Includes charts and conversion tables. Request direct from Irvington on company letterhead.

Centrifugal Castings. Janney Cylinder Co., 6 pp, illus. Describes facilities for producing centrifugally-cast, nonferrous alloys. Includes chart of physical properties and chemical analysis. (43)

Hydraulic-Setting Refractories. Johns-Manville, 12 pp, illus. Describes methods used to produce five types of Firecrete and three types of Blazecrete, hydraulic setting refractories for services through 3000 F, and suggests uses for them. (44)

Industrial Radiography. M. W. Kellogg Co., 24 pp, illus. Portable gamma ray sources for industrial radiography using cobalt 60, cesium 137, and iridium 192. (45)

Small Tubing. Mackenzie Walton Co., 25 pp. Size ranges of precision seamless tubing in copper and copper-base alloys available. (46)

High-Impact Thermoplastic Resin. Marbon Corp., 20 pp, No. CY-2. Processing recommendations, physical data, chemical resistance data and results of aging tests for Cycolac, a new resinous polymer in which the basic material is styrene. (47)

Prime Coated Pressed Wood. Masonite Corp., 2 pp, illus. Properties and uses of Presdwood panels with hard, tough primer coat applied by special process at factory. (48)

Ovens. Michigan Oven Co., 20 pp, illus. A guide to industrial ovens. (49)

Dispensers and Taping Machines. Minnesota Mining & Mfg. Co., 16 pp, illus. Manual containing types of dispensers and taping machines for pressure-sensitive tape. (50)

Carbon Specialties. Morganite Inc., 12 pp, illus. Design data reference for carbon specialties, including chemical and physical properties, and typical blank sizes and parts. (51)

Precision Investment Casting. National Precision Casting Corp., 4 pp, illus. Case histories of savings effected by using investment casting for small or intricate parts. (52)

Plastic Pipe. National Tube Div., U. S. Steel Corp., 11 pp, illus. Properties, applications, chemical resistance, fittings, installation and other data on polyethylene plastic pipe. (53)

Powder Metals. Plastic Metals, Div. of National-U. S. Radiator Corp., 12 pp, illus, No. 2. Covers the production of iron powders as well as nonferrous and alloy powders with suggestions for the utilization of metal powders. (54)

Vulcanized Fibre. National Vulcanized Fibre Co., 18 pp, illus. Brochure gives broad picture of this material, including how it is made, its outstanding properties, fabrication and forming, shapes and grades available, and representative applications. (55)

Primers. Neilson Chemical Co., 4 pp, No. 55-133. Describes Lyfanite coatings, corrosion resistant phosphate coatings for aluminum, ferrous alloys and other metal surfaces. (56)

Stripper. Northwest Chemical Co., 1 p. A liquid stripper to remove organic finishes from plastics, particularly imperfect articles. (57)

Boron Carbide. Norton Co., 16 pp, illus. A handbook on boron carbide, elemental boron, and other stable, boron-rich materials. (58)

Metal Laminate. O'Sullivan Rubber Co., 4 pp. Describes Sullvyne-Clad metal laminate, a vinyl plastic sheeting bonded to metal to form a pre-finished material. Includes physical and chemical properties of laminate. (59)

Forgings. Pittsburgh Forgings Co., 12 pp, illus. Describes facilities for production and design of "round" forgings in the broad sense of the term. Includes illustrative descriptions of typical forgings. (60)

Gasket Materials. Rogers Corp., 12 pp. General data and recommendations for using Duroid gasket materials, and data sheets on seven specific gasket sheeting materials, which include a

Manufacturers' Literature

general description, typical test values and service recommendations. (61)

Spun and Formed Shapes. Roland Teiner Co., Inc., 5 pp. Hydroforming and spinforming of fabrications of all sizes. (62)

Polystyrene Rolls and Sheets. Plastics Div., Seiberling Rubber Co., 2 pp. Covers availability, specifications, physical properties, chemical resistance, and adhesives for high impact polystyrene calendered rolls and sheets. (63)

Thread-Cutting Screws. Shakeproof Co., 32 pp. Thread, point and head specifications for thread-cutting screws for use in metals and plastics to eliminate tapping. Weight data also included. (64)

Signaling and Recording Attachment. Sperry Products, Inc., 2 pp, illus, No. 50-130. Gives applications and description of semi-automatic testing with Type UR Reflectoscopes. (65)

Steel Castings. Steel Founders' Society of America, 4 pp, illus, No. 69. Describes reduced costs and expanded plant capacity through use of steel castings. Also lists characteristics of steel castings. (66)

Heat Treating. Surface Combustion Corp., 8 pp, Vol. 6, #2. House organ featuring two articles on automation for modern heat treating. Other articles on controlled atmosphere processes and new automatic dewpoint control systems. (67)

Plasticizer. Swift & Co., 2 pp. Describes Esterflex B-1, a new type of plasticizer for general purpose use and particularly for polyvinyl chloride compounds. It is neither a monomeric or polymeric type of product, and contains both polar and non-polar groups. (68)

Tool, Dies, Plastic Molds. Sylvania Electric Products, Inc., 11 pp, illus. Describes facilities for design engineering and manufacture of tool, dies and molds. (69)

Cold Roll Forming. The Yoder Co., 88 pp, illus. Designed as a text or reference book on the function, scope and economies of cold-roll forming. (70)

Other Available Literature

Irons and Steels • Parts • Forms

Steel Weldments vs. Castings. Acme Tank & Welding Div., United Tool & Die Co., 20 pp, illus. Booklet furnishes basic facts about steel plate fabrication as compared to casting for manufacturers and designers of heavy machinery, equipment, service apparatus and components. (75)

Malleable Iron. Albion Malleable Iron Co., 15 pp, ill. A thorough analysis of malleable iron for casting, the booklet contains a definition of malleable iron, its relationships to other ferrous materials, micrographs, physical properties and relative cost figures for several parts now being manufactured. (76)

Metal Powder Parts. American Sinterings Div. of Engineered Plastics, Inc., 4 pp, ill. Facilities for fabrication of ferrous or nonferrous metal powder parts. (77)

Wire Parts and Metal Stampings. Art Wire & Stamping Co., 4 pp, ill, No. 875. Illustrates a variety of wire parts and small metal stampings that this company can produce. (78)

Steel Casting Design. Atlantic Steel Castings Co., illus. Offers detailed information on how to economically design steel castings. (79)

Stainless Steel Tubing. J. Bishop & Co., 7 pp. Mechanical, capillary, hypodermic, and small tubular specialties in stainless steel, nickel, and nickel alloys. Table of comparative properties of various alloys. (80)

Steel Tubing. Bundy Tubing Corp., ill. Steel tubing for various industrial applications. (81)

Alloy Comparison Chart. Cannon-Muskegon. Comparison chart of AISI, SEA, ACI, AMS, WAD, PWA alloy specifications. (82)

Stainless Steel Heads. G. O. Carlson, Inc. Various lists of typical uses and dies available. Price lists included. (83)

Alloy Pipe and Tubing. Carpenter Steel Co., 2 pp, illus. Properties and corrosion resistance data for nickel-molybdenum iron and nickel-molybdenum-chromium iron alloy pipes and tubes. (84)

Metal Powder Parts. Chicago Powdered Metal Products Co., 4 pp, ill. Brass, bronze and iron powdered metal parts. Includes chart of physical characteristics of standard Camet materials. (85)

Circular Steel Shapes. Commercial Shearing & Stamping Co., 24 pp, illus, No. P-3. Covers company's range of cold formed circular steel blanks, flanged and dished shapes, produced from stocked dies. (86)

Lead Treated Steel. Copperweld Steel Co., Steel Div., 8 pp, illus. Mechanical properties and applications of lead treated steels. (87)

Forged Metal Quality. Drop Forging Assn., 6 pp, ill. Detail of several hot working processes emphasizing improvements achieved in metal structure using these processes. (88)

Steel Fabrication. Gussett Boiler & Welding, Inc., 8 pp, ill. Describes facilities for steel and alloy plate fabrication of vessels, tanks, hoppers, stacks, machine bases and other weldments. (89)

Stainless Steel Castings. Kolcast Industries, Inc., 4 pp, illus. Large stainless steel precision castings made by the frozen mercury process. (90)

Pressed Parts. Lenape Hydraulic Pressing & Forging Co. Catalog shows numerous parts press formed by this company illustrating the kinds of jobs this firm can perform. (91)

Clad Steels. Lukens Steel Co., 6 pp, illus. Price comparison of clad steels and solid high alloys. (92)

Stainless Steel Castings. The Ohio Steel Foundry Co., 4 pp, ill, No. 651-C. Compositions of Fabrite stainless steels for casting and illustrations of numerous corrosion resistant castings. (93)

Powder Metal Parts. Powdered Metal Products Corp. of America. Booklet shows advantages of powder metallurgy in manufacture of such parts as gears, sprockets and valves. (94)

Steel Tubing. Sawhill Tubular Products, Inc., 16 pp. Information on grades and size range of company's steel tubing. (95)

Spun Metal Parts. Spincraft, Inc., No. 3. Data book on metal spinning and fabricating gives data on process and help in designing for economical production. (96)

Ferrous Castings. Superior Foundry, Inc., 14 pp, ill. Describes multiple coring, economical methods and facilities for casting various alloys. (97)

Clad Metals. Superior Steel Corp., 24 pp, ill. An introduction to clad metals offering a comprehensive survey of the manufacture and application of stainless, copper, brass and other clad steels. (98)

Malleable and Alloy Iron Castings. Texas Foundries, Inc., 20 pp, illus. Describes foundry facilities and provides case histories of applications of malleable iron. (99)

Steel Forgings. Titusville Forge Div., Struther Wells Corp., 8 pp, illus. Describes facilities for precision forging of parts regardless of size, metal or alloy. Shows numerous parts produced. (100)

Stainless and High Alloy Tubing. Trent Tube Co., 48 pp, illus. Classifies types of tubing, giving typical applications, physical, chemical and electrical properties for each. Information on welding, bending and installation techniques. (101)

Rigidized Metal Bonded Plywood. United States Plywood Corp., 8 pp, ill. Gives special features, advantages and wide variety of uses for Armorply, sheet metal bonded plywood. (102)

Stampings. WLS Stamping Co., 4 pp, ill. Describes high-speed, low-cost stamping process using "speed tooling" method. (103)

Steel Strip. Weirton Steel Co., 20 pp, ill. Characteristics of electrolytic zinc-coated sheets and strip, high-tensile steel and high carbon strip cold-rolled spring steel being manufactured by the company. (104)

Nonferrous Castings. Wellman Bronze & Aluminum Co., 16 pp, ill, No. 53. Includes facilities of this company for producing a variety of nonferrous castings and wood or metal patterns. (105)

Nonferrous Metals • Parts • Forms

Bronze Casting Alloys. American Manganese Bronze Co., 50 pp, ill. Revised edition gives composition, characteristics and applications of the principal copper alloys used to make castings. (109)

Manufacturers' Literature

Prefinished Metal Sheet. American Nickeloid Co., 24 pp, ill. Properties and fabrication information on prefinished metal sheet. Includes examples and case histories of uses. (110)

Precision Investment Castings. Arwood Precision Casting Corp., 16 pp, ill. Informative article on precision investment castings. Includes table of ferrous and nonferrous alloys recommended as most adaptable for this process. (111)

Precision Castings. Atlantic Casting & Engineering Corp., 12 pp, illus. How to obtain nonferrous castings cast to ordinary machining tolerances. Describes process and gives alloy specifications. (112)

Beryllium Alloys. Beryllium Corp., 20 pp, ill. The uses of beryllium and its alloys. (113)

Magnesium. Brooks & Perkins, Inc., 8 pp, illus. Describes company's facilities for working magnesium and titanium. Includes fabricating, assembling and finishing. (114)

Pre-Coated Metal Strip. Coated Coils Corp., 3 pp, ill. Versatile color finishes produced by an exclusive process is illustrated by actual sample of Enamel-strip, the metal coil precoated in color. Address inquiries to Mr. Marvin Richfield, Adv. Mgr., 513 W. 30th St., New York, N. Y.

Bimetals. W. M. Chace Co., 36 pp, ill. Describes and explains 22 uses of bimetals as actuating elements in temperature responsive devices. (115)

Static and Centrifugal Castings. Duraloy Co., 16 pp, illus, No. 3354-G. Describes facilities for producing high alloy static and centrifugal castings. Engineering data on castings for heat, corrosion and abrasion resistance. (116)

Magnesium and Aluminum Castings. Eclipse-Pioneer Div. Foundries. "Book of Facts" shows company's facilities for custom-making aluminum and magnesium castings. (117)

Die Cast Parts. The Electric Auto-Lite Co., Die Casting Div., 16 pp, illus, No. G137. Describes facilities for economical manufacture of quality die castings. (118)

Elgiloy. Elgin National Watch Co., Abrasives Div., 2 pp. Corrosion resistant data and other characteristics of corrosion and fatigue resistant alloys. (119)

High Density Metal. Fansteel Metallurgical Corp., 16 pp, illus. Properties and uses of Fansteel 77 Metal, machinable tungsten-copper-nickel alloy, 50% heavier than lead, used for counterweights, flywheels, vibration damping, and radiation shielding devices. (120)

Aluminum Alloy. Frontier Bronze Corp., 24 pp, illus. Describes Alloy "40-E", a high strength alloy containing zinc with magnesium, titanium and chromium, which needs no heat treatment. Separate data sheets on specifications, composition and properties. (121)

Inserts. Groov-Pin Corp. Self tapping insert used as original equipment and for salvage and repair of stripped threads. (122)

Precision Manufacturing Service. Hamilton Watch Co., 16 pp, ill. Special alloy casting, rolling, drawing to fine specifications. (123)

Bright Nickel. Harshaw Chemical Co., 4 pp, illus. Describes Perglow bright nickel plating. (124)

Die Castings. The Hoover Co., 12 pp, illus, No. 853. Shows this company's facilities for producing zinc and aluminum die castings. Includes design helps, describes applications. (125)

Precision Alloy Moldings. Lebanon Steel Foundry, 2 pp. Announcement of the Ceramicast process utilizing ceramic molds for precision castings adaptable to almost any casting size or alloy. (126)

New Titanium Alloy. Mallory-Sharon Titanium Corp., 4 pp. Properties of MST 6AL-4V, a high stability titanium alloy for use at temperatures to 750 F. Includes heat treating data and stability test results. (128)

Zirconium. Metal Hydrides, Inc., 2 pp, No. 700-C. Physical properties and handling instructions for zirconium metal, hydride, and powder. (129)

Aluminum and Zinc Castings. Monarch Aluminum Mfg. Co. File pages on this company's developments in aluminum and zinc castings. Each folder distributed kept up-to-date. (130)

Cored Forgings. National Cored Forgings Co., Inc., 8 pp, ill. Advantages and typical examples of cored forgings made of brass, bronze, copper and other nonferrous metals. (131)

Aluminum Extrusions. Precision Extrusions, 12 pp, ill. Describes aluminum extrusion process with tables of physical properties and recommended applications. (132)

Spun Shapes. Phoenix Products Co., Metal Spinning Div., 4 pp, ill. Describes Phoenixspun methods for spinning spherical and extra deep-drawn contours. (133)

Investment Casting Alloys. Precision Metalsmiths, Inc. Chart covers stainless, low alloy and tool steels, nickel alloys, copper-base alloys and aluminum alloys. Complete chemical analysis and mechanical properties given. Chart rates alloys as to castability, machinability, corrosion resistance, etc. (134)

Carbon Graphite. Pure Carbon Co., Inc., 32 pp, ill, No. 52. Technical data on description, properties, applications and specifications of Purebon carbon graphite. (135)

Wire Cloth. Reynolds Wire Co., 8 pp, ill, No. 1a/30a. Available materials, styles and sizes of industrial wire cloth, furnished in ferrous and nonferrous materials. (136)

Rigid Metals. Rigidized Metals Corp., 16 pp, ill. Light-weight, high strength rigidized strip and sheet available in ferrous or nonferrous metal. (137)

Nonferrous Alloys. Riverside Metal Co. A reference and guide to alloy specifications of phosphor bronze, nickel silver, cupro nickel and beryllium copper. (138)

Magnesium and Aluminum Castings. Rolle Mfg. Co., Inc., 16 pp, ill. Background history and current progress of magnesium and aluminum castings. Includes illustrated case histories and data on new magnesium-zirconium alloys. (139)

Centrifugal Castings. Sandusky Foundry & Machine Co., 6 pp, ill. Specification chart for ferrous and nonferrous alloys for centrifugal castings. (140)

Magnesium Sand Castings. South Gate Aluminum & Magnesium Co., 12 pp, ill. Features the facilities of this company for producing precision aluminum and magnesium sand castings and precision machined parts. (141)

Titanium Tubing. Superior Tube Co., 8 pp, illus, No. 43. Information on fabrication of unalloyed titanium tubing. Covers heat treating, pickling, welding, brazing and machining. (142)

Light Metal Castings. Thompson Products, Inc., 8 pp, ill. Describes a complete line of precision die castings for various industrial uses. (143)

Nonferrous Castings. Universal Castings Corp., 16 pp, ill. Facilities for production of precision nonferrous castings. (144)

Nonmetallic Materials • Parts • Forms

Honeycomb Material. Aircomb Section, Douglas Aircraft Co., Inc. Announces the development of Aircomb, a honeycomb structure of Kraft paper impregnated with a phenolic resin. Precut in any thickness from 1/16 to 5 in., it is said to be 16 times as rigid as an equal weight of steel, durable, fire-resistant, pest-resistant, has excellent insulation and soundproofing properties. (149)

Corrosion Inhibiter. Solvay Process Div., Allied Chemical & Dye Corp., 17 pp, illus. Use of sodium nitrite in corrosion prevention. (150)

Plastic Pipe. American Agile Corp., 12 pp. Charts give physical and mechanical properties of polyethylene and polyvinyl chloride pipe and tubing and their chemical resistance to various reagents. (151)

Thermosetting Plastics. American Cyanamid Co. Thirty success stories show outstanding sales advantages of using Cyanamid plastics, which are hard-wearing, hard-surfaced and hard-to-break. (152)

Extruded Plastics. Anchor Plastics Co. 12 pp, ill. Applications of thermoplastic rods, tubes and shapes. Summary of properties of plastics materials with usage table. (153)

Fiber Glass Reinforced Plastics. Apex Electrical Mfg. Co., 4 pp, illus. Case histories of custom molded fiber-glass parts featuring pressure vessels. (154)

Plastisols. Arbonite Corp. Information file on plastisols and plastic protective coatings and linings. (155)

Reinforced Silicone Rubber. Arrowhead Rubber Co., 18 pp, illus., No. S-11. Technical data on Arcosil 2184, a fiberglass fabric impregnated with silicone rubber. Material has wide temperature range, high strength, and flexibility. (156)

To obtain literature appearing on these pages, please refer to easy-to-use reply card on pages 67 and 68

Manufacturers' Literature

Gaskets, Packings, Etc. Auburn Mfg. Co., 3 pp, ill. Discusses the various products produced by this company, including gaskets, packings, washers, spacers, seals, shims and bushings. (157)

Rubber Processing. Automotive Rubber Co., Inc., 12 pp, illus, No. 500. Describes plant's facilities for fabricating and rubber coating special production parts. (158)

Woven Glass Roving. Bigelow-Sanford Carpet Co., Inc., 2 pp. Describes mechanically bonded glass fabric used in reinforced plastics, and lists advantages. (159)

Ceramic Bodies. Centralab Div., Globe Union Inc., 28 pp, illus, No. 720-10M. Comprehensive survey of this firm's ceramic production. Includes description of engineering properties of ceramics, design information, allowable tolerances, and indicates broad scope of ceramic products with data dimensions. (160)

Plastisol. Chemical Products Corp., 8 pp, ill. Chem-O-Sol plastisol formulation for industrial and consumer products. Instructions for use and several case histories of coated products. (161)

Compounded Elastomers. Chicago Rawhide Mfg. Co., 32 pp, ill. Characteristics, properties and engineering applications of Sirvene compounded elastomers. (162)

Reinforced Fiberglass Parts. Clearfield Plastics, Inc., 22 pp, illus. Discusses company's facilities for producing molded contoured parts. Suggests design and specification techniques. (163)

Extruded Plastic. Conneaut Rubber and Plastics Co., 4 pp. ill, No. CR-53. Die making and production facilities of rubber and plastic extrusions. (164)

Molded and Extruded Rubber. Continental Rubber Works, 8 pp, No. 100. Gives dimensions of molded and extruded rubber with cross sectional illustrations. Also condensed SAE and ASTM specification chart. (165)

Custom Laminations and Extrusions. Dobeckmun Co., 4 pp, illus. Describes facilities for custom laminations of customers' materials or specialized conversion of films, foils and papers for applications such as pipe wraps, duct facing, polyethylene coated cloth, etc. (166)

Silicone. Dow Corning Corp., 2 pp, No. 7-222. Technical data on two solvent-free, solid silicone resins for formulating special silicone resin solution coatings. (167)

Neoprene. Elastomer Div., E. I. du Pont de Nemours & Co., 8 pp, illus, No. 65. Latest developments and applications of Neoprene. Also includes data sheet on Hypalon. (168)

Tetrafluoroethylene Resin Coated Glass Fabrics. E. I. du Pont de Nemours & Co., Fabrics Div., 4 pp. Electrical, mechanical, chemical, thermal, and forming properties of Teflon-glass fabrics as well as toxicity precautions and suggested uses. (169)

Dry Coloring Polyester Resins. Ferro Corp., 2 pp. Explains types of colors manufactured by Ferro that can be used in the dry state. (170)

Laminating Materials. Flexfirm Products. A folder with 7 technical bulletins Nos. 1, 2, 3, 111, 112, 113, 105 and fabrication instructions for polyester resin impregnated glass cloth mat supplied in dry state ready for layup. (171)

Reinforced Wood. Gamble Bros., Inc., 4 pp. Wood coated with high strength thermoplastic gives higher strength wear, and impact resistance. (172)

Plastic Products. General American Transportation Corp., Plastics Div., 10 pp, ill. Brochure shows plant facilities for production from blueprint through assembly and packing. Also lists wide variety of this company's molded plastics. (173)

Shell Molding. General Electric Co., Chemical Materials Dept., 28 pp. Demonstrates shell molding process for economical production of cast parts. (174)

Industrial Laminates. General Electric Co., 8 pp. How to select particular grade of laminated plastic sheet applicable to specific design problems. Charts give description, properties and applications. (175)

Rubber and Plastics Extrusions. General Tire & Rubber Co., 16 pp, No. 786. Contains specifications, performance characteristics, tolerances and properties available in common rubber and plastic compounds. (176)

Insulating Sheet. Glastic Corp., ill. Property data and comparison charts on Glastic MM, Fiberglas reinforced laminate with high strength and heat resistance for electrical insulation. (177)

Epoxy-Glass. Haveg Corp., 3 pp, No. 6. Description of Haveg 9710. an epoxy-glass having good chemical and thermal resistance. Table indicates performance under various chemical and thermal conditions. (178)

Adhesives. Hercules Powder Co., 32 pp. The use of Vinsol resin as a low-cost component of adhesives. Product applications divided into rubber-base adhesives, vinyl resin adhesives, and adhesives based on styrene, phenol, urea-starch, cellulose, and polymerized oil. (179)

Polyester Resins. Hooker Electrochemical Co. Folder of data sheets describing fire-resistant and polyester resins. (180)

Rigid Polyvinyl Chlorides. Kaykor Industries, Inc., Div. of Kaye-Tex Mfg. Corp., 6 pp. Chemical and physical properties of Vyflex rigid polyvinyl chloride plates and sheets. (181)

Compression Molded Plastics. Kuhn & Jacobs Molding & Tool Co., 10 pp, ill, No. E-604. Illustrates the facilities of this company for producing compression molded plastics. Includes specifications. (182)

Ceramic Fibers. L. O. F. Glass Fibers Co., 4 pp, illus. Describes quartz and glass fibers for high temperature insulation. (183)

To obtain literature appearing on these pages, please refer to easy-to-use reply card on pages 67 and 68

Refractory Porcelain. McDanel Refractory Porcelain Co., 36 pp, ill. Catalog of high temperature porcelain products with physical, mechanical and electrical properties. (184)

Reinforced Wood. Met-L-Wood Corp., 15 pp, illus, No. 521. Describes combined wood and metal sheets, providing light weight and high strength. (185)

Glass Reinforced Plastics. Molded Fiberglass Co., 6 pp, illus. Facilities for producing glass fiber reinforced plastics molding. (186)

Glass Bonded Mica. Mycalex Corp. of America, 24 pp, ill. Design information for parts to be machined from glass bonded mica. (187)

Plastic Resins and Compounds. Naugatuck Chemical Div., U. S. Rubber Co., 8 pp, ill. Vinyl, polyester and elastomeric resins and compounds, applications, properties and processing. (188)

Plastics Moldings. Nosco Plastics, Inc., 10 pp, illus. Facilities for plastics moldings. (189)

Packing. Quaker Rubber Corp., 6 pp, ill. Complete line of materials for hydraulic and other types of packing. (190)

Plastics Reinforcing Material. Raybestos-Manhattan, Inc., 46 pp, illus, No. T-55. Comprehensive analysis of asbestos cloths, felts and papers containing varying percentages of asbestos and glass fibers for use as reinforcement in both high and low pressure plastics laminates. Charts full range of engineering properties of asbestos materials and of high and low pressure laminates with various specific resins. (191)

Molded Rubber Products. Roberts Toledo Rubber Co., 16 pp, illus. Describes company's facilities for producing molded rubber parts. (192)

Plastics Extrusions. Schwab Plastics Corp., 20 pp, illus. Rigid and flexible plastics extrusions and plastics fabrications. (194)

Parts for Wear Applications. Spaulding Fibre Co., Inc., 4 pp, illus. Shows vulcanized fibre and thermosetting plastics parts for long wear applications. (195)

Molded Rubber. Spencer Rubber Products Co., 8 pp, ill. Rubber part production facilities. (196)

Steatite Ceramic. Star Porcelain Co., 1 p, No. 600. Standard ways of insulating washers and bushings of steatite for high temperature insulation applications. (197)

Reinforced Plastics. Strick Plastics Corp., 4 pp, illus. Describes reinforced polyester laminate with good thermal, electrical, chemical and mechanical properties. Typical applications given. (198)

Fabricating Laminated Plastics. Taylor Fibre Co., 15 pp. Reprints of NEMA-authorized engineering information: Recommended Practice for Fabricating Laminated Plastics. (199)

Synthetic Rubber Sheet and Roll Goods. Acadia Div., Western Felt Works, 2 pp, samples. Ten samples clipped to

Manufacturers' Literature

chart of physical specifications. Durometer, tensile and elongation characteristics. (200)

Finishes • Cleaning and Finishing

Chromate Conversion Coatings. Allied Research Products, Inc., 4 pp, ill, No. 8. Complete data on the basic characteristics of Iridite chromate conversion coatings, and their functions on various metals. (205)

Metal Coatings. American Chemical Paint Co. Illustrated folder, check list and reference guide to chemicals and processes for metal preservation. (206)

Hot Dip Galvanized Coatings. American Hot Dip Galvanizer's Association Inc., 16 pp, ill. Description of hot dip galvanizing process in industrial and consumer item applications. (207)

Coated Abrasive. Carborundum Co., Coated Products Div., 8 pp, ill, No. 2. Characteristics and applications of Resin Industrial Cloth, a new coated abrasive product for dry-belt grinding. (208)

Corrosion Control. Carpenter Steel Co., 28 pp, illus. Contains corrosion resistance tables, charts, and test results for stainless tubing and pipe. (209)

Chromium Plating. Dawson Corp., ill. Folder describes packaged chromium plating plant designed for precision control of dimensional build-up or salvage of wear components, tools and gages. (210)

Wear Resistant Coating. Electrolizing Corp., 16 pp. Detailed data on the Electrolizing Process for increasing the life and efficiency of metal parts subjected to wear, abrasion and corrosion. (211)

Spray Painting. Finish Engineering Co., Inc., 14 pp, ill. Equipment for masking and spray painting small parts in production volume. (212)

Metallized Ceramic Coating. Frenchtown Porcelain Co., 4 pp, illus. Metal-to-ceramic coating produces surface to which metal part or other metallized ceramic parts may be soft or hard soldered without special preparation. (213)

Protective Coating. Gates Engineering Co., 4 pp, ill. Uses and application of air-curing, liquid neoprene protective coating that can be applied by brush or spray and eliminates use of accelerator. (214)

Industrial Finishes. Glidden Co., 11 pp, ill. Properties and advantages of Nu-Pon primer and enamels. (215)

Cold Cleaners. E. F. Houghton & Co., 4 pp. Advantages and working principles of Hought-Clean 439 and 440, Houghton's cold cleaners for the cleaning of metal parts in power washes at room temperature. (216)

Cleaning Automotive and Aircraft Parts. Kelite Products, Inc., 2 pp, ill, No. 17-R. Degreasing and decarburizing agent. Formula 555, for aircraft and automotive parts. (217)

Barrel Finishing. Lord Chemical Corp., 32 pp, ill. Introductory bulletin describes various compounds for precision barrel finishing. (218)

Silicone-Base Finish. Midland Industrial Finishes Co. Brochure describes silicone-base finish, said to resist heat of 500 F without discoloration. (219)

Aluminum-Chromium Paint. Monroe Co., Inc., 4 pp, ill, No. C54-8. Includes detailed application data on Monco-Alochrom, an aluminum-chromium paint for exterior and interior surfaces of all kinds. (220)

Blast Cleaning and Dust Control. Pangborn Corp., No. 227. Describes Rotoblast equipment designed for blast cleaning of castings, forgings and heat treated parts. Emphasizes features of Rotoblast wheel. (222)

Precious Metal Electroplating. Technic, Inc., 4 pp, ill. Price list for soluble precious metals available for electroplating. (223)

Finishing Forgings. J. H. Williams & Co., 20 pp, ill. Describes company's facilities for all phases of forging, including cleaning and finishing. (224)

Methods and Equipment

Brazing Alloys. The American Platinum Works, 46 pp, ill. Handy-sized manual gives detailed description of the brazing process, the alloys used, design of joints and other considerations for successful joining. (230)

Welding Insert. Arcos Corp., 10 pp, ill. Welding process technique where welding is done on one side only by means of insert process. Suitable for butt welding of stainless and alloy steel pipe, both seamless and welded. (231)

Indicating Extensometer. Baldwin-Lima-Hamilton Corp., 8 pp, ill, No. 4212. Description of various types of extensometers with specifications. (232)

Metallurgical Testing Equipment. Buehler Ltd., 12 pp, illus. Describes metallurgical specimen mount presses. (233)

Chromium Molybdenum Welding. Champion Rivet Co., 13 pp, No. CM-55. Low hydrogen welding electrodes for chromium molybdenum alloy steels. Data includes physical and mechanical properties of welds, chemical analysis of weld deposit, and discussion of welding procedure. (234)

Weldment Assemblies. Continental Foundry & Machine Tool Co., 6 pp, illus. Advantages of large welded assemblies, typical applications, and production facilities available. (235)

Lettering Machine. Ralph C. Coxhead Corp., 4 pp, ill. Lists the many advantages of using the Vari-Typer lettering machine in the drafting room. (236)

Sintering Furnaces. Drever Co., 12 pp, illus, No. B-101. Describes types of furnaces for sintering metal powder products. (237)

Explosive Rivets. E. I. du Pont de Nemours & Co. (Inc.), Explosive Dept., 39 pp, ill, No. A-2785. Gives sizes, installation and variety of uses of du Pont's explosive rivets. (238)

Studs and Bolts. Erie Bolt & Nut Co., 60 pp, illus, No. 446. Catalog of company's available nuts, bolts and studs. Price lists given. (239)

Lightweight Flexible Ducting. Flexible Tubing Corp., 4 pp, illus. Various types of lightweight flexible ducting engineered for air handling, fume removal, dust collection, and materials handling. (240)

Fasteners. H. M. Harper Co., 8 pp, ill, Vol. 19, No. 2. Various case histories of the applications of Harper's fasteners, emphasizing corrosion-resistant bolts. (241)

Conveyor Furnaces. Harper Electric Furnace Corp., 4 pp, ill, No. 454. Describes mesh belt conveyor furnaces. Gives specifications and dimensions. (242)

Induction Heating Generators. Induction Heating Corp., 4 pp, ill. Technical data and case histories with applications of 2½- and 3½-kw induction heating generators. (243)

Die Casting Machines. Lester-Phoenix, Inc. Folder gives description, features and specifications of this company's die casting machines and injection molding machines. (244)

Sintering Furnaces. Lindberg Engineering Co., 8 pp, illus, No. 230. Describes various types of sintering furnaces. (245)

Welding Aluminum Sheet. Linde Air Products Co., 1 p, No. 54-6R. Instructions for oxyacetylene welding of aluminum sheet. (246)

Induction Heating Control. Minneapolis-Honeywell Regulator Co., 16 pp, illus, No. HT-1. Discusses automatic temperature control for induction heating equipment. (247)

Tungsten Carbide Compacting Tools. National Carbide Die Co., 4 pp, ill. Discusses various tungsten carbide compacting tools as they are applied to powdered metallurgy. (248)

Compression Tester. National Forge & Ordnance Co., 4 pp, illus. Describes crush compression tester for in-plant testing. (249)

Spectrograph. National Spectrographic Sales Corp., 8 pp, illus. Spectrographic equipment and accessories. (250)

Wrinkle Finishes. New Wrinkle, Inc., ill. Folder shows typical products utilizing Wrinkle finishes. (251)

Induction Heating. The Ohio Crankshaft Co. Describes plant survey and possible applications to which induction heating might be put for greater production economy. (252)

Program Controllers. Tinius Olsen Testing Machine Co., 4 pp, ill, No. 48. Describes the new line of electronic controllers for automatic production testing and research testing. (253)

Vacuum Unit. Radio Corp. of America, Scientific Instruments Section, 4 pp, ill, No. EM-61. Features applications, description and specifications of vacuum unit for vacuum deposition of metals and laboratory work. (254)

Self-Locking Set Screws. Set Screw & Mfg. Co., 20 pp, ill. Illustrates and describes various types of standard and self-locking set screws with data on dimensions, prices, heads, points and materials. (255)

Heat Treating Equipment. Stanwood Corp., 4 pp. Brief description of types of heat treating equipment with suggested applications. (256)

Abrasion Resistance Tester. Taber Instrument Corp., 4 pp, illus, No. 5409. Tester evaluates resistance of surfaces to rubbing abrasion. Includes tests of painted, lacquered, electroplated surfaces and plastic coated materials. (257)

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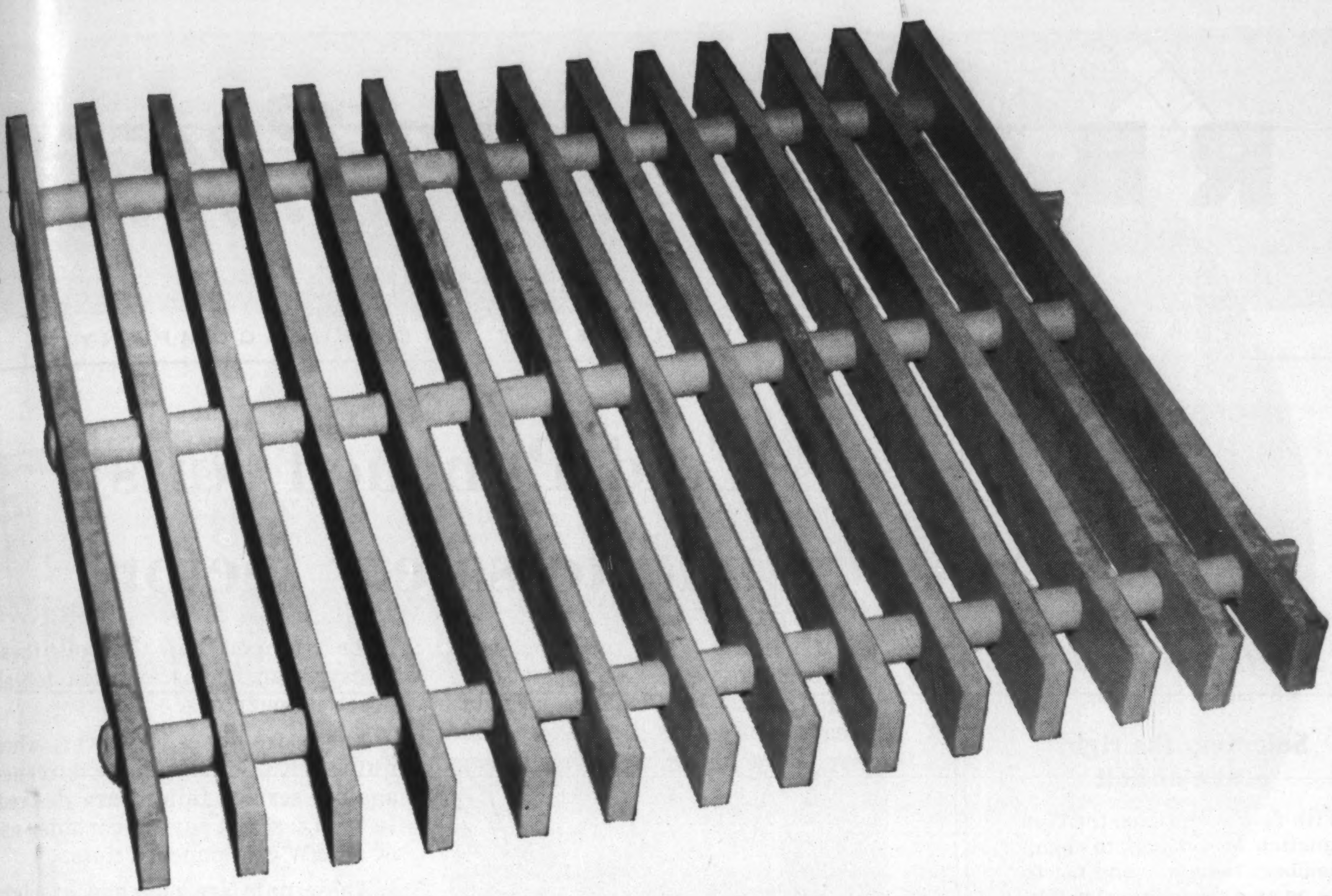

STILL LIKE NEW

...After 100 Operations at 2300 deg. F

This tray made of HASTELLOY alloy X has been heated to 2300 deg. F on more than 100 different occasions and still shows no signs of oxidation or distortion. In each cycle the tray is heated to 1300 deg. F for an hour, and then to 2300 deg. F for an additional half hour. Trays made from other materials, and used under the same conditions, failed from oxidation and warpage after a few firing cycles.

The tray is 18 in. square and is fabricated from HASTELLOY alloy X sheared plate. It is used to support heavy molds during a tungsten carbide bonding process.

HASTELLOY alloy X has given similar good service in other furnace applications such as muffles, flame targets, rollers, and heating tubes. It is equally suitable for use in jet engine tailpipes, afterburner components, and other aircraft parts exposed to heat and oxidation.

For complete information on properties and forms, ask for the booklet, "HASTELLOY Alloy X."

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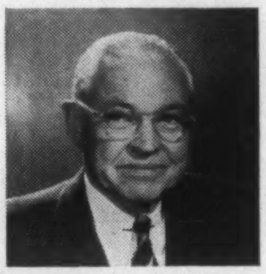
P-54-2706

RB&W FASTENER BRIEFS

RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY



Technical-ities

By John S. Davey

Selecting the right grade of bolt

With few exceptions, the true function of a bolt is to clamp members together, and not to act as an axle or fulcrum. The residual tension set up in the bolt keeps joints tight.

There's rarely need for costly alloy steel fasteners—not when 3 physical grades of steel can satisfy most "clamping" applications.

SAE grade 1 offers 55,000 psi minimum tensile strength; grade 2, 68,000 psi; and grade 5, approx. 120,000 psi.

The first is used for fasteners which are stress-relief annealed to increase ductility. The next provides low carbon fasteners with a bright finish. The last goes into high-carbon, heat treated black fasteners identifiable by three radial dashes on the head.

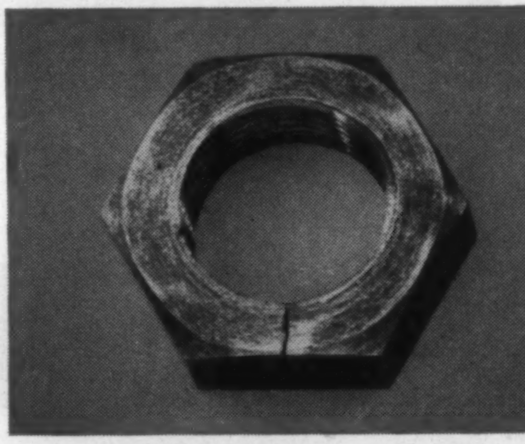
SOME SUGGESTIONS

In terms of holding power, the stronger bolts and cap screws can cost you less than the cheaper bright ones. For example, either a ⅝" with three radial dashes or a ¾" bright cap screw can be used for a safe working load of 20,000 pounds. But being smaller, the high strength one costs less. However, if the same diameter is desirable, then fewer bolt holes need be made and faster assembly achieved when a product is designed to make use of high strength bolts.

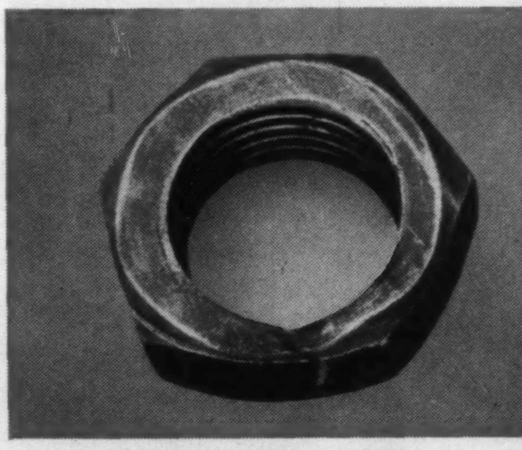
In short, for more pounds of clamping effort per dollar, use high strength fasteners; for more pieces per dollar, use the lesser grades.

Cold Punched Nuts add to safety factor

Nuts dilate when tightened on a bolt. They also adjust plastically to distribute the load over many threads. Since nuts are overdesigned to be stronger than the bolt, these stresses can be disregarded for all practical purposes.



How a defect in hex bar caused split in nut machined from it.



Drift punch had to distort cold punched nut severely, far beyond its yield point before it cracked.

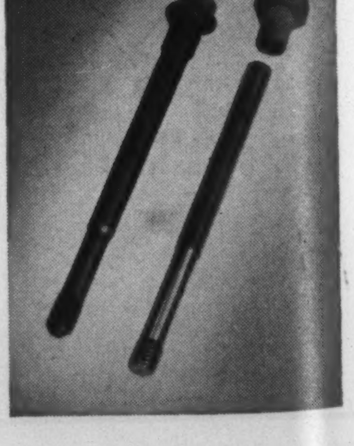
There are times, however, when nuts with optimum assurance against service failure are desired. In such cases, it pays to consider use of RB&W cold punched nuts.

These nuts are punched at right angles to the metal's flow lines . . . same direction as stress encountered in service. No unrelieved stresses are set up. The initial punching automatically reveals any defects. Repunching, an RB&W development, then not only trues up the hole for clean, concentric threads, but also serves as a drift punch test, automatically checking the soundness of these safest of nuts.

For help in applying standard fasteners to assure more assembly strength and less assembly time, feel free to call in an RB&W man. Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, N.Y.

Plants at: Port Chester, N.Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. Additional offices at: Ardmore, (Phila.), Pa.; Pittsburgh; Detroit; Chicago; Dallas; San Francisco.

One-piece fastener better than two

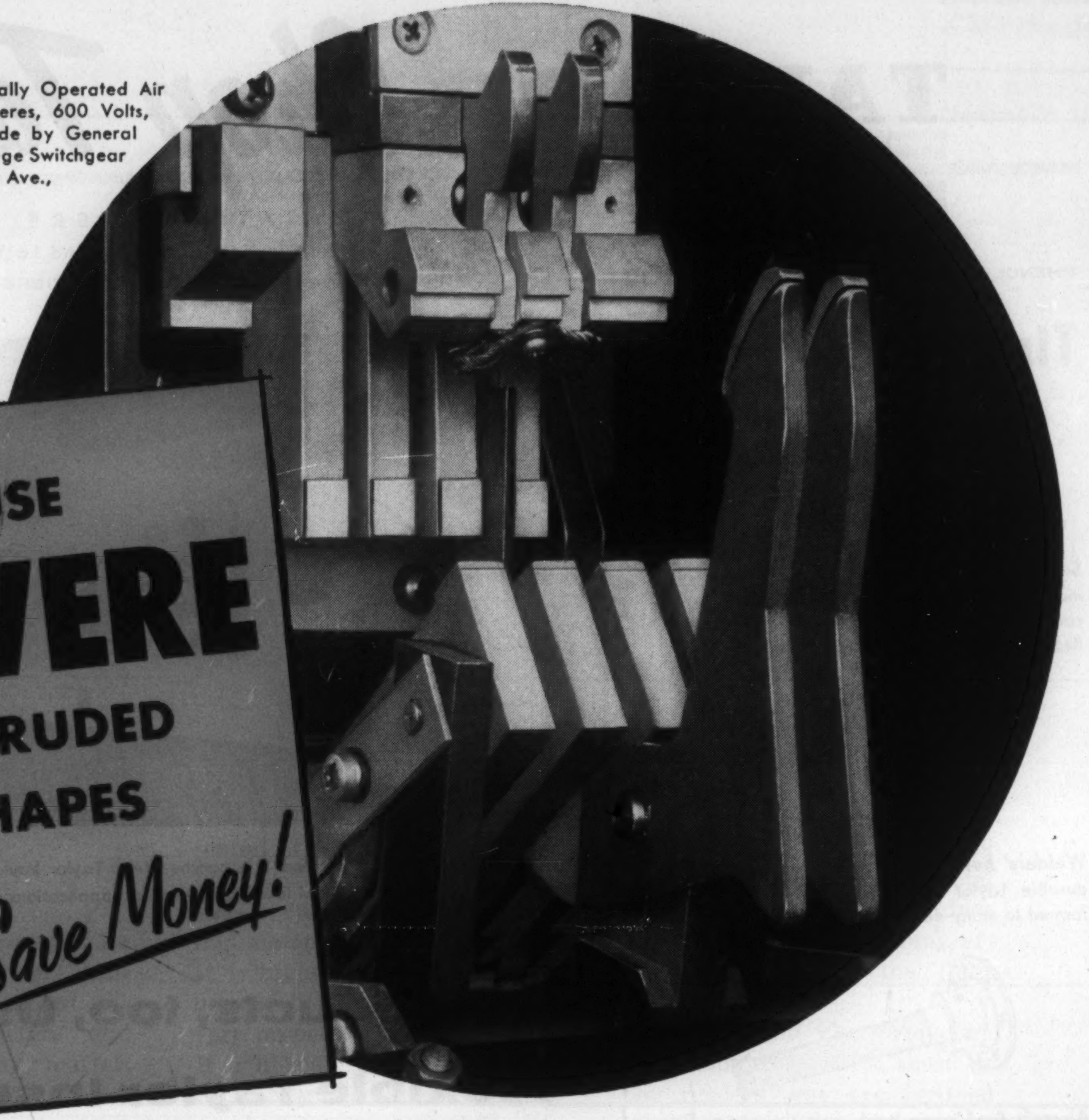


One particular oil filter used to be fastened with stud and cap sleeve made by screw machine. This was only until RB&W pointed out that a one-piece fastener could be formed easily on a cold header. The advantages gained are obvious. The single fastener *cost* less, and took *less time* to assemble.

RB&W makes a tremendous variety of strong, uniform standard fasteners to improve assembled metal products. If any of these don't fill a particular need, perhaps an RB&W "special" can be developed that will.

For more information, turn to Reader Service Card, Circle No. 349

G-E Type AK-1-50 Electrically Operated Air Circuit Breaker, 1600-amperes, 600 Volts, A-C. One pole shown. Made by General Electric Company, Low Voltage Switchgear Department, 6901 Elmwood Ave., Philadelphia, Pa.



USE

REVERE

EXTRUDED

SHAPES

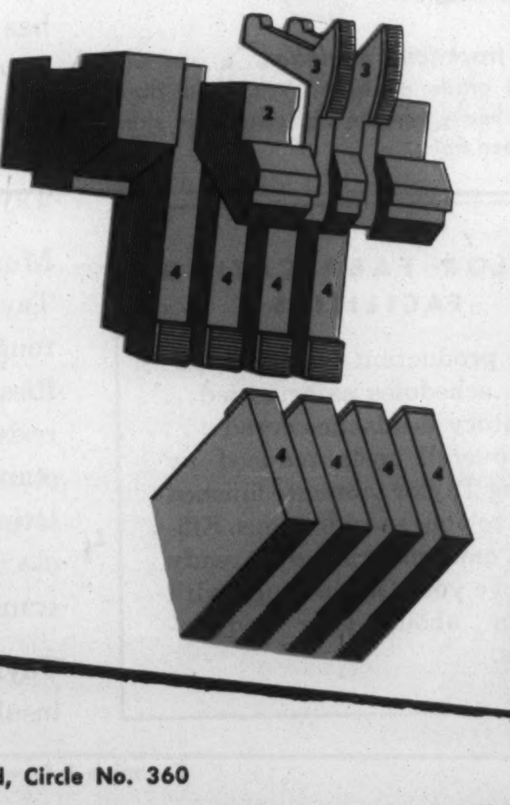
—they Save Money!

Here is the General Electric Type AK-1-50 Electrically Operated Air Circuit Breaker, 1600-ampere frame size used to protect low-voltage systems. The picture shows one pole of the contact, and in order to photograph it, the housing and the arc-quencher parts were removed. Note the Revere Extruded Shapes, and Rectangular Rod. There are three shapes, and one size of bar, all in copper, because copper has the highest electrical conductivity of all commercial metals.

If these shapes had to be "hogged" out of bar, they would be expensive, due to the machining time, and the scrap generated. While copper scrap is readily salable at good prices, it is costly from the machining standpoint. Extruded shapes by Revere, preformed to the desired contours, usually reduce machining to a cutting-off operation, plus such minor details as drilling which cannot be done during extrusion. Shapes naturally cost more per pound than bar or rod, but the ultimate saving makes up for the difference and more, sometimes several times.

Are you doing much machining of copper? If so, look into Revere Extruded Shapes. They may save money, and speed up production as well. See the nearest Revere Sales Office.

Sketch showing details of contacts. Nos. 1, 2 and 3 are extruded and drawn copper shapes. No. 4 is rectangular copper bar. Cross hatching represents special arcing contacts brazed to the copper.



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For more information, turn to Reader Service Card, Circle No. 360

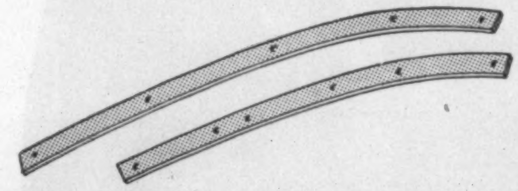
TAYLOR
Laminated Plastics
Vulcanized Fibre

Shop Talk

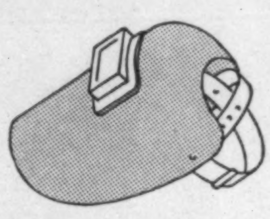
TAYLOR FIBRE CO.
Plants in Norristown, Pa. and La Verne, Calif.

PHENOL—MELAMINE—SILICONE—EPOXY LAMINATES • COMBINATION LAMINATES • VULCANIZED FIBRE • POLYESTER GLASS ROD

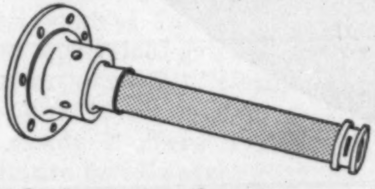
Tips for designers



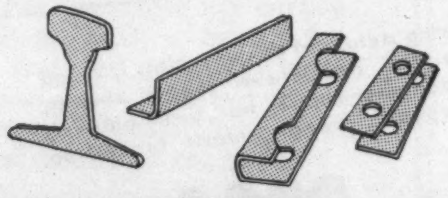
Sealing strips for crew doors of 4-engine commercial transport plane are made from Taylor canvas base phenol laminate . . . chosen for its flexibility and long-wearing qualities.



Welders' helmets are fabricated from tough, durable Taylor Vulcanized Fibre . . . readily formed to many desired contours.



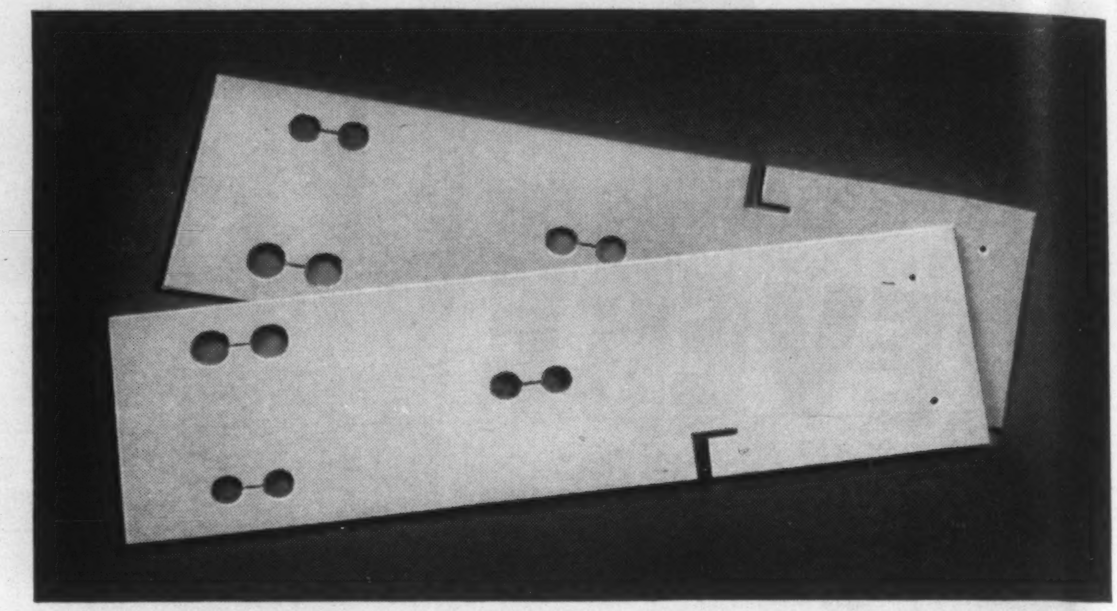
Aircraft fuel gage tank unit uses a tube of Taylor Epoxy Glass Base Laminate . . . an unusual material noted for excellent corrosion resistance and electrical insulation over a wide humidity range.



Railroad track-joint insulation, a specially developed grade of Taylor Vulcanized Fibre, withstands heavy impacts and mechanical stress of high-speed trains.

TAYLOR FABRICATING FACILITIES

Your production can be simplified...schedules safeguarded...inventory headaches cured . . . and overall costs reduced by having Taylor fabricate finished parts to your specifications. Efficient, modern facilities are ready to serve you. Get in touch with Taylor about your requirements.



Support for antenna lead in is punched from Taylor Insulation . . . a lightweight, flexible material ideal for mechanical applications and rough usage.

New Products, too, Use Tough, Flexible Taylor Insulation

When you're designing new products or modernizing old ones, take advantage of the unique characteristics . . . both in performance and economy . . . of Taylor Insulation. Also called "fish paper," this versatile material has long been a favorite of designers. It offers properties that have not been duplicated by more recently developed materials . . . many of which Taylor also makes.

Most outstanding properties of Taylor Insulation are its extreme toughness, excellent bending qualities, high dielectric strength and arc resistance. Its durable surface withstands abrasion. It is an ideal insulating material for slot wedges in electric motors, for field coils, for transformers, and for arc shields.

Taylor Insulation is not limited to insulation work. Its strength, toughness and resistance to many chemicals qualify it for gaskets, washers, metal box liners and a wide variety of mechanical products.

To insure uniformity of its useful characteristics, Taylor Insulation's base is a high grade rag paper manufactured in Taylor's own paper mill. Taylor Insulation comes in sheets, strips, rolls and coils for high speed production equipment . . . sheets approximately 56″ x 90″, and rolls up to 56″ wide.

Write to Taylor for a copy of its general catalog with complete technical data on this and other grades of Taylor vulcanized fibre and laminated plastics. And have a Taylor engineer consult with you for specific recommendations on your particular materials application.

For more information, turn to Reader Service Card, Circle No. 373

One point of view

A refreshing viewpoint

Generally speaking, engineers and designers are not completely open-minded about accepting new materials and processes. For that matter, all of us are likely to resist change somewhat. Thus, it was of interest to read recently what a prominent architect had to say about the arrival of stainless steel as a full-fledged building material. Here are his thoughts:

"I've observed that new materials make my life as an architect more interesting by making it more complicated. Each new material presents a new challenge to architects. We have to reappraise older methods and materials and must try to explore the full potential of the new material.

"To my mind, stainless steel is one of the most promising materials available to us. It is highly rigid, durable and beautiful. Yet it was these very properties that once made it a difficult material to work with. Now that metal-working people have overcome these difficulties, architects have an entirely new field in which to exercise their imaginations.

"I'm glad we have stainless steel as an architectural material because now we can try new things. Architecture seemed to be entering a sterile period because of too much emphasis on materials of limited possibilities.

"The Stainless Steel Skyscraper has exceeded my fondest hopes. In using a new material, certain difficulties are expected, but all these have been surmounted. The special finish used on the panels gives an interesting and pleasing effect regardless of the light that strikes it."

We would like to recommend this attitude to those of our readers who are inclined to follow the lines of least resistance and work only with those things they have become familiar with. Perhaps they, too, can find excitement in new challenges as well as new answers to old problems.

T. C. Du Mond

Which finish for a metal product . . .

Lacquer, *sprayed hot, is used on this Besly-Welles machine tool because it speeds assembly and delivery.* *(Hercules Powder Co.)*

Enamel *is used on refrigerators because it provides a hard, glossy finish resembling porcelain enamel.* *(E. I. duPont de Nemours & Co., Inc.)*

Lacquer or Enamel?

Both have important advantages, both have important limitations. You must consider the product, and you must consider your production facilities. This article will help you make an intelligent choice.

by **John B. Campbell,** *Associate Editor, Materials & Methods.*

■ Although there are at least six or seven distinct types of organic coatings, lacquers and synthetic enamels are the two types most widely used today for metal products. If you are responsible for selecting a finish for a metal product, it may be well to consider the important differences between present-day lacquers and synthetic enamels. Your choice between a lacquer and an enamel will have far-reaching effects on the production line. It may also have appreciable effects on unit cost, on sales volume and on customer satisfaction.

A pigmented lacquer (only pigmented finishes are considered in this article) is essentially a solvent solution of resins and plasticizers with pigments dispersed throughout. When a lacquer is applied to a metal surface, the solvent evaporates and the resins and plasticizers precipitate out to form a dry pigmented film. Since the solvents evaporate at ordinary temperatures, ordinarily no heat is needed to "cure" a lacquer. However, heat may be applied to speed up drying if faster production is needed.

Most lacquers used on metal products are based on nitrocellulose. Excluding pigment, the vehicle solids portion of a nitrocellulose lacquer may consist simply of about 80% nitrocellulose resin and 20% plasticizer, or up to one-half or more of the nitrocellulose may be replaced by a nonoxidizing or semi-oxidizing alkyd resin.

A synthetic enamel consists essentially of one or more thermosetting or oxidizing synthetic resins, solvent thinner and pigments. When a synthetic enamel is applied to a metal surface, the thinner evaporates and the resins oxidize and/or polymerize to form a dry pigmented film. An "air dry enamel" is formulated to set up without heating, whereas a "baking enamel" must be heated to produce optimum film properties.

Although many different types of synthetic enamels are available today, the alkyd types are most common. Excluding pigment, the vehicle solids portion of an alkyd enamel may consist entirely of oil-modified glyceride phthalate resin, or it may contain anywhere from 5 to 50% or more of urea- or melamine-formaldehyde resin. Other commonly used enamels are based on phenolics, epoxies, acrylics, vinyls, silicones and combinations of these resins.

Making a choice

The number of variables involved makes it difficult to set precise limits on the suitability of lacquers or enamels. However, the most important questions to consider in choosing between a lacquer and an enamel are discussed briefly below.

Is appearance important? If so, what kind of appearance will best promote sales? A glossy finish can be obtained more readily and more economically with an enamel than with a lacquer. The glossiness usually lasts longer outdoors, too. Wrinkled and other special textures are not available in lacquers. On the other hand, some pastel and metallic colors may be easier to achieve with lacquers, and lacquers also take a better polish than enamels.

Is durability important? Will the product have a long life, or will it soon be discarded? If durability is important, what service conditions must be considered? Enamels have better adhesion and better resistance to outdoor exposure than lacquers. Both lacquers and enamels can be formulated to withstand ordinary chemical environments such as solvents, soaps, fruit juices, etc., but enamels can be made to withstand much more severe environments than lacquers. Enamels also withstand higher temperatures.

What are the size and shape of the part? Size and shape are important for two reasons. They determine to some extent the capacity of the conveyors, the tanks or spray booths, and the ovens or drying space. They also determine the importance of the materials cost of the finish. The higher materials cost of lacquers may be significant on large-area parts but becomes insignificant on very small parts.

How will the finish be applied (assuming the method is predetermined)? Both lacquers and enamels can be readily sprayed, but enamels are generally more satisfactory for dipping, roller-coating or flow-coating.

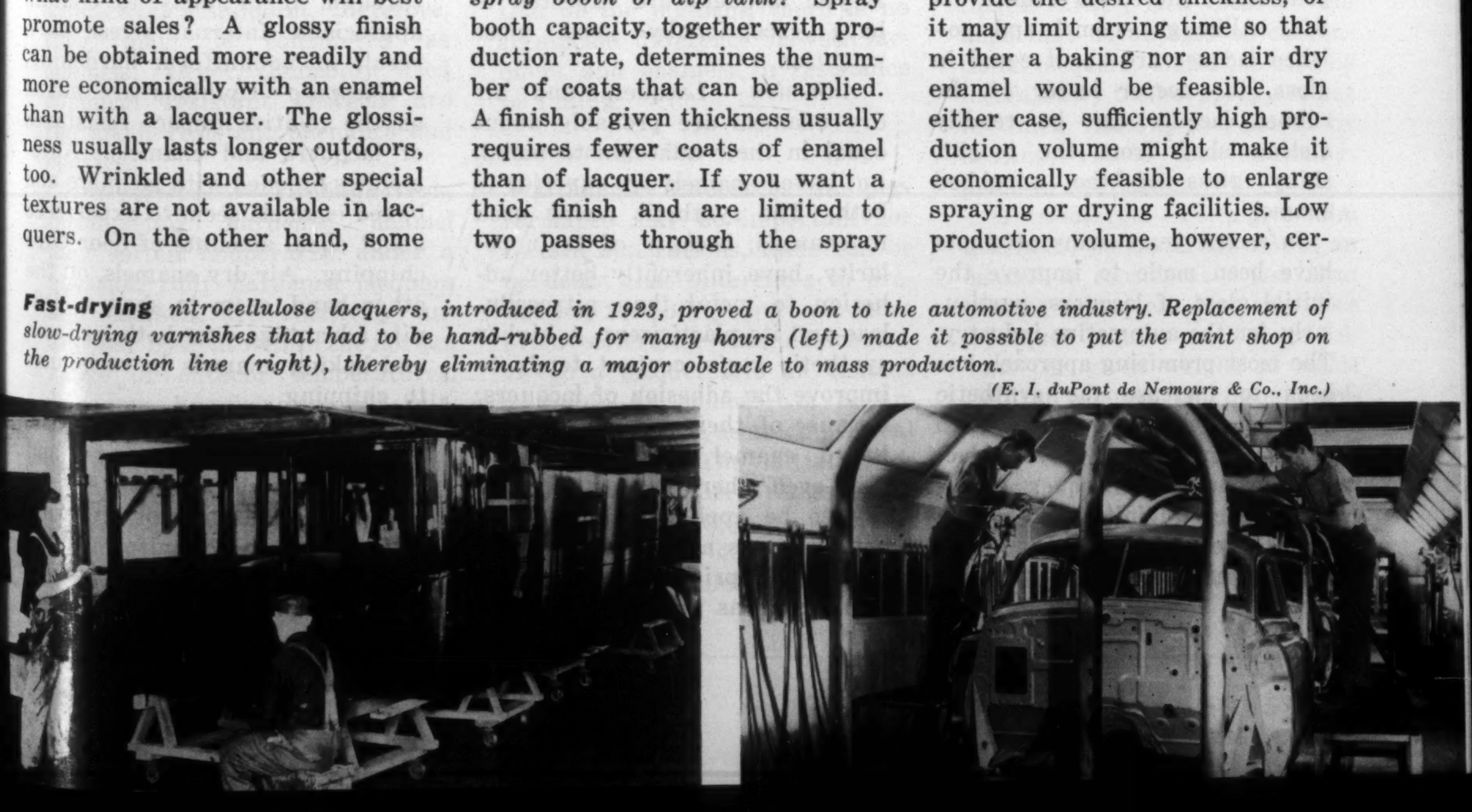
What is the capacity of the spray booth or dip tank? Spray booth capacity, together with production rate, determines the number of coats that can be applied. A finish of given thickness usually requires fewer coats of enamel than of lacquer. If you want a thick finish and are limited to two passes through the spray booth, you will have to use an enamel or enlarge the spray booth.

Are drying or baking ovens available? If so, what is their capacity? Knowing the clearance, length and heating capacity of the ovens, together with conveyor limitations, part size and production rate, you can readily estimate the maximum feasible drying or baking schedule. If it exceeds 20-30 min at 200 F, you can probably use a baking enamel. If not, or if ovens are not available, your choice is limited to lacquers and air dry enamels.

If ovens are not available, how much space is available for drying between coats and after the final coat has been applied? Since a lacquer dries more quickly, it would be preferable to an air dry enamel where drying space is limited, or where immediate assembly or packaging would save steps in handling.

How valuable is the part? If a finishing defect occurs, can the part be scrapped or must it be repaired? A lacquer finish can be touched up quickly without interfering with normal production flow, whereas a baked enamel finish usually must be entirely recoated and rebaked to cover up a defect.

What will be the production volume and rate? A high production rate may limit the number of coats that can be applied so that an enamel is needed to provide the desired thickness, or it may limit drying time so that neither a baking nor an air dry enamel would be feasible. In either case, sufficiently high production volume might make it economically feasible to enlarge spraying or drying facilities. Low production volume, however, cer-



Fast-drying *nitrocellulose lacquers, introduced in 1923, proved a boon to the automotive industry. Replacement of slow-drying varnishes that had to be hand-rubbed for many hours (left) made it possible to put the paint shop on the production line (right), thereby eliminating a major obstacle to mass production.*

(E. I. duPont de Nemours & Co., Inc.)

tainly favors the finish requiring the least additional investment.

More details on the characteristics of lacquers and enamels are given in the remaining two sections of this article. Keep in mind that the characteristics of both lacquers and enamels can be varied over wide ranges. If lacquers are said to compare unfavorably with enamels in a particular characteristic, this statement does not necessarily mean that a lacquer having a comparable characteristic could not be obtained. What the statement implies is that such equality could not be obtained only by sacrificing other characteristics which would be desirable, or even necessary, for most applications.

Comparing performance

Neglecting cost and production feasibility for the present, let us compare lacquers and synthetic enamels strictly on a performance basis.

Initial gloss — Higher initial gloss is possible with enamels. With proper surface preparation and adequate undercoating, an enamel generally rates at least 90 on a glossmeter, whereas a lacquer seldom exceeds 65.

However, the gloss of a lacquer that is subsequently polished equals, and sometimes may slightly exceed, the gloss of an enamel. Polishing enamel often reduces its initial gloss and is generally believed to reduce its life. Although enamel and polished lacquer are about equal in gloss, the deeper luster of the rubbed lacquer can be readily distinguished from the bright, shiny gloss of the unrubbed enamel.

In recent years many attempts have been made to improve the initial gloss of lacquers, particularly for the automotive industry. The most promising approach has been to increase the synthetic resin-nitrocellulose ratio and to add melamine resin to the lacquer formulation. Lacquers equaling enamels in initial gloss have been developed, but they have been unsatisfactory in other respects.

Gloss retention—In indoor exposures, gloss retention of enamels and lacquers is not significantly different, both dulling slightly over a period of years. In outdoor exposures, however, enamels generally show better gloss retention than lacquers for a period of six to nine months. After that time, enamels show little or no advantage and often lose gloss faster than lacquers. Unlike an enamel, a lacquer can usually be restored to its original gloss by polishing.

Much work has been done to improve the early gloss retention of lacquers. High-resin nitrocellulose lacquers with initial gloss equal to that of enamels have not only shown gloss retention approaching that of enamels, but have also exhibited much less variation in gloss retention than conventional lacquers. Tested on automobiles, they have reduced the incidence of rubbed-through areas resulting from excessive polishing. On the other hand, they have shown a greater tendency toward "cold checking" (checking in cold weather); greater softening and consequent dirt pick-up in the southern summer sun; and much less ease of repair, ordinarily an important advantage of lacquers for automobiles.

Currently, new lacquers based on acrylic resins rather than nitrocellulose are being evaluated by auto manufacturers. These acrylic lacquers are expected to have exceptionally good gloss retention.

Adhesion — Lacquers and air dry enamels are probably about equal in their adhesion to metal, but baked enamels are superior to both. The synthetic resins used in enamels, because of their polarity, have inherently better adhesion to metal than nitrocellulose and its plasticizers. A higher synthetic resin content tends to improve the adhesion of lacquers. Because of their better adhesion, baked enamel primers may be used even where lacquer topcoats are to be applied. Adhesion of both lacquers and enamels is improved by prior surface treatments such as phosphate coating.

In contrast, intercoat adhesion of lacquers is somewhat better than that of enamels, since lacquer solvents tend to soften the surface of the undercoat and blend the two layers together. However, this difference in intercoat adhesion is not usually significant.

Hardness—The relative hardness and abrasion resistance of lacquers and enamels depends considerably upon the completeness of cure at any given time. On mass-produced items, enamel baking schedules are seldom sufficient for a complete cure, so that enamels often continue to cure for some weeks or months after baking. Lacquers usually reach their maximum hardness quickly, especially when force dried. As a result, initial hardness of a lacquer often exceeds that of an enamel, but a fully cured enamel may be as hard as, or harder than, a lacquer.

Lacquers and enamels also differ in the uniformity of hardness throughout the film. Since drying and setting-up proceeds from the outside surface, the faster drying lacquers tend to be much more uniform in hardness throughout the thickness of the film than the slower setting enamels. The hardness gradient in new enamel films makes them more susceptible to damage than lacquers during the early part of their life. When the enamel is finally cured through, it is likely to contain appreciable internal stress as a result of nonuniform hardening.

Chipping—Opinions are mixed on the relative impact resistance of lacquers and enamels. Automobiles finished with lacquers and baked enamels seem to experience about equal amounts of door edge chipping. Air dry enamels, on the other hand, seem to show a definite advantage over both lacquers and baking enamels in resistance to chipping.

Checking—Over a reasonable life period, both lacquers and enamels usually resist serious checking. Because of internal stresses due to nonuniform hardening, however, enamels are inherently more likely to check than lacquers, and many enamels ultimately fail by fine checking.

Blistering — Although opinion varies, there is probably little difference in blistering behavior between lacquers and enamels. Blistering occurs when moisture beneath the film evaporates and, being unable to permeate the film, tends to rupture it. A lacquer is inherently more permeable than an enamel and, therefore, presumably less likely to blister. However, a suitable primer and good intercoat adhesion largely eliminate the occurrence of moisture beneath the film.

Solvent resistance — Both lacquers and enamels can be provided with sufficient solvent resistance for most applications, but enamels, because of their crosslinked structure, are inherently more solvent resistant than lacquers. A lacquer, of course, is always soluble in its original solvents, which generally consist of esters, ketones and strong alcohols. A fresh, incompletely hardened enamel, however, is more likely to be attacked than a lacquer.

Chemical resistance — Highly chemical resistant finishes are available both as lacquers and enamels. However, the acid resistant vinyls, the most common chemical resistant lacquers, are only technically lacquers since they provide optimum properties only when force dried at high temperatures (250-375 F). From a practical standpoint, therefore, they may be considered as enamels. Other commonly used chemical resistant enamels are the alkali resistant phenolics and epoxies.

Heat resistance—Although fresh, incompletely hardened enamel may soften temporarily under a hot sun, fully hardened lacquers and enamels are relatively unaffected by heat within the normal range of outdoor temperatures. Lacquers, however, are not suitable for continuous exposure to temperatures above 150 F. Alkyd and alkyd-amine enamels tend to degrade at about 250 F, but more heat-resistant enamels are available. Phenolic and epoxy types are suitable for continuous exposure up to 350 F, silicones up to 500 F, and silicone-alkyd types as high as 700 F.

Cold resistance—Lacquers and enamels are relatively unaffected by exposure to cold within the normal range of outdoor temperatures. Lacquers are more likely than enamels to lose flexibility at unusually low temperatures such as might be encountered in the Arctic.

Flexibility—Enamels generally can withstand more flexing and deformation than lacquers and, consequently, are probably more suitable for thin sheet parts subject to flexing, or for parts to be stamped out from prepainted strip.

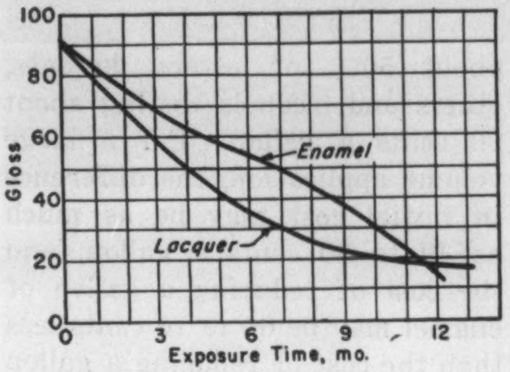
Color—Because of their faster set-up and lower curing temperatures, lacquers sometimes permit a wider selection of colors and color effects than enamels. For example, the production schedule may require baking an enamel at 260 F. At this temperature the alkyd resin may become discolored and make it impossible to obtain a satisfactory pastel color. Furthermore, some of the new metallic color effects cannot be obtained with an enamel because their slower set-up permits the aluminum flake to assume a preferred orientation. On the other hand, wrinkle and other special textured surfaces cannot be obtained with a lacquer.

Fading—Since fading is a function of the pigment, there is no significant difference between lacquers and enamels in resistance to fading.

Comparing cost

Although differences in performance may be important for certain applications, there can be no doubt that differences in production feasibility and cost more often determine the choice between a lacquer and an enamel.

Build—An enamel can be applied up to twice as thick per coat as a lacquer. The initial solids content of lacquers ranges from about 25 to 40% for lacquers compared with 40 to 60% for enamels. In addition, lacquers must be reduced considerably more than enamels prior to application. For example, lacquers for spraying auto bodies are usually reduced more than 100% by volume, whereas enamels are reduced only 10-15%. The higher volatiles content of a lacquer is necessary to compensate for the greater viscosity of nitrocellulose compared to synthetic resins and for the more rapid evaporation of some of the solvents required for lacquers.



Gloss retention of lacquers and enamels—average for all colors.
(Adapted from a paper by N. P. Beckwith, April 1952)

The higher build of an enamel means that a finish of given thickness may require only about half as many coats of enamel as of lacquer. Consequently, an enamel may require less labor, less equipment and less floor space in its application.

The build of a lacquer can be improved by increasing the proportion of synthetic resin to nitrocellulose. Builds approaching those of enamels have been achieved in some high-resin lacquers, but these finishes, as mentioned earlier, lack some of the important advantages of conventional lacquers. Build can also be increased by the hot spray process in which viscosity is reduced by heating, rather than thinning, prior to application.

Materials cost—For a given film thickness, the materials cost of an enamel is considerably less than that of a lacquer. Not only does a lacquer require much more solvent per given weight of solids than an enamel, but lacquer solvents are also more expensive than enamel thinners. Whereas enamel solvents consist entirely of aromatic and aliphatic hydrocarbons costing from 20 to 40 cents a gallon, lacquer solvents contain about 50% of esters, ketones, ethers and alcohols costing about 90 cents a gallon. For a large volume application, the difference in initial cost may be as much as 40 to 50 cents a gallon, and the cost of reducing a gallon of enamel may be 60 to 70 cents less than the cost of reducing a gallon of lacquer.

As a result, the materials cost of a lacquer may approach twice the cost of an enamel of the same dry film thickness. An industrial finish supplier estimates the materials cost of 1000 sq ft of a 1-mil dry film of lacquer applied by spraying (assuming no losses during application) at about $11.75 and the comparable figure for enamel at about $6.30. Lacquers are seldom applied by dipping or flow-coating because of the large volume of "low boiling" solvent that is lost by evaporation from an open tank.

Dry-to-touch time — Lacquers dry to the touch much more rapidly than enamels. Depending upon atmospheric conditions, lacquers may dry to the touch within a few minutes, whereas air dry enamels require several hours (although styrenated alkyd enamels which approach lacquers in their drying rates have recently been introduced).

Fast drying provides many advantages. A lacquer film has less time to pick up dust and dirt; hence, atmosphere conditions are less critical. Since lacquer hardens more rapidly, there is less chance of marring the finish during handling. Much less drying space is required. Several coats of lacquer can be applied in fairly rapid succession, then simultaneously force dried. Lacquers can also be masked soon after application, making it possible to apply two or more colors before force drying.

Baking schedules—A lacquer, when force dried, requires lower temperatures and usually shorter times than an enamel. On auto bodies, for example, standard baking schedules are 20-30 min at 180-200 F for a lacquer and 20-45 min at 250-260 F for an enamel. Thus, enamels require more expensive ovens, more power and more floor space.

The above schedule for enamel is not sufficient for a complete cure, and current automobile enamels currently reach full hardness only after a few months of service. Maximum baking temperature is limited by heat degradation of the alkyd; where lower production rates permit, a longer baking time at a slightly lower temperature would be preferable. However, baking time is limited by established production rates. A new, faster baking automotive enamel has recently been developed. It not only bakes considerably harder than previous enamels but, being more heat resistant, is also much less sensitive to "overbaking" in the current range of baking temperatures.

Where durability is important, a lacquer may be applied over a high quality enamel primer, e.g., a primer that must be baked. Thus the primer, not the top coat, may determine the oven capacity needed.

Polishing—A lacquer must be polished where high initial gloss is important, as on an automobile. Polishing requires extra labor, equipment, floor space and production time. It also tends to thin out the film to some extent. Although an enamel may be polished to restore gloss during service, little is gained by polishing an enamel after application; in fact, polishing can easily damage the finish unless the enamel is fully cured.

Undercoats—A lacquer can readily be applied over another lacquer or over a fully cured enamel. Conversely, a baking enamel can be applied over another enamel if the undercoat has been formulated so that it can withstand a second bake; and it can be applied over a lacquer if it is not baked at too high a temperature. However, applying a lacquer over an enamel which, in turn, had been applied over a lacquer, might cause trouble, since the lacquer solvents would tend to penetrate through the enamel to the original lacquer, swelling and tending to lift the enamel film.

Repairs—Lacquers are much more adaptable to repairs than enamels. Since a coat of repair lacquer tends to blend into the old lacquer film, no repair spot is apparent, and only the damaged section need be repainted. Furthermore, the lacquer repair coat dries rapidly at room temperature. To repair an enamel, it is necessary to repaint the entire part to avoid a spotty appearance. In field repairs on automobiles, baking is usually not feasible, and it is customary to use an air dry enamel which may or may not look the same as the original baked enamel when it cures.

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R. F. Wint, Hercules Powder Co.

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Symposium on "High Resin Nitrocellulose Finishes" sponsored by National Paint, Varnish and Lacquer Assn., Hot Springs, Va., Apr. 1952.:
N. P. Beckwith, "High Resin Lacquers for Metal Finishing"
D. E. Leever, "The Function of Resins in Enamel Lacquers"
R. F. Wint, "High Solids Nitrocellulose Lacquers"

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C. H. Parker, "A Study of the Effects of Amino Resins in Protecting the Air-Film Interface of High-Gloss Lacquers"
G. R. Somerville, "Para Tertiary Butyl Bensoic Alkyd Resins for High Resin Content Nitrocellulose Lacquers"
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A. J. LaPointe, "Automotive Enamels"
R. I. Peters and H. W. Redshaw, "Evaluation of Automotive Finishes"
Ralph J. Wirshing, "Lacquer as a Finish on Automobiles"

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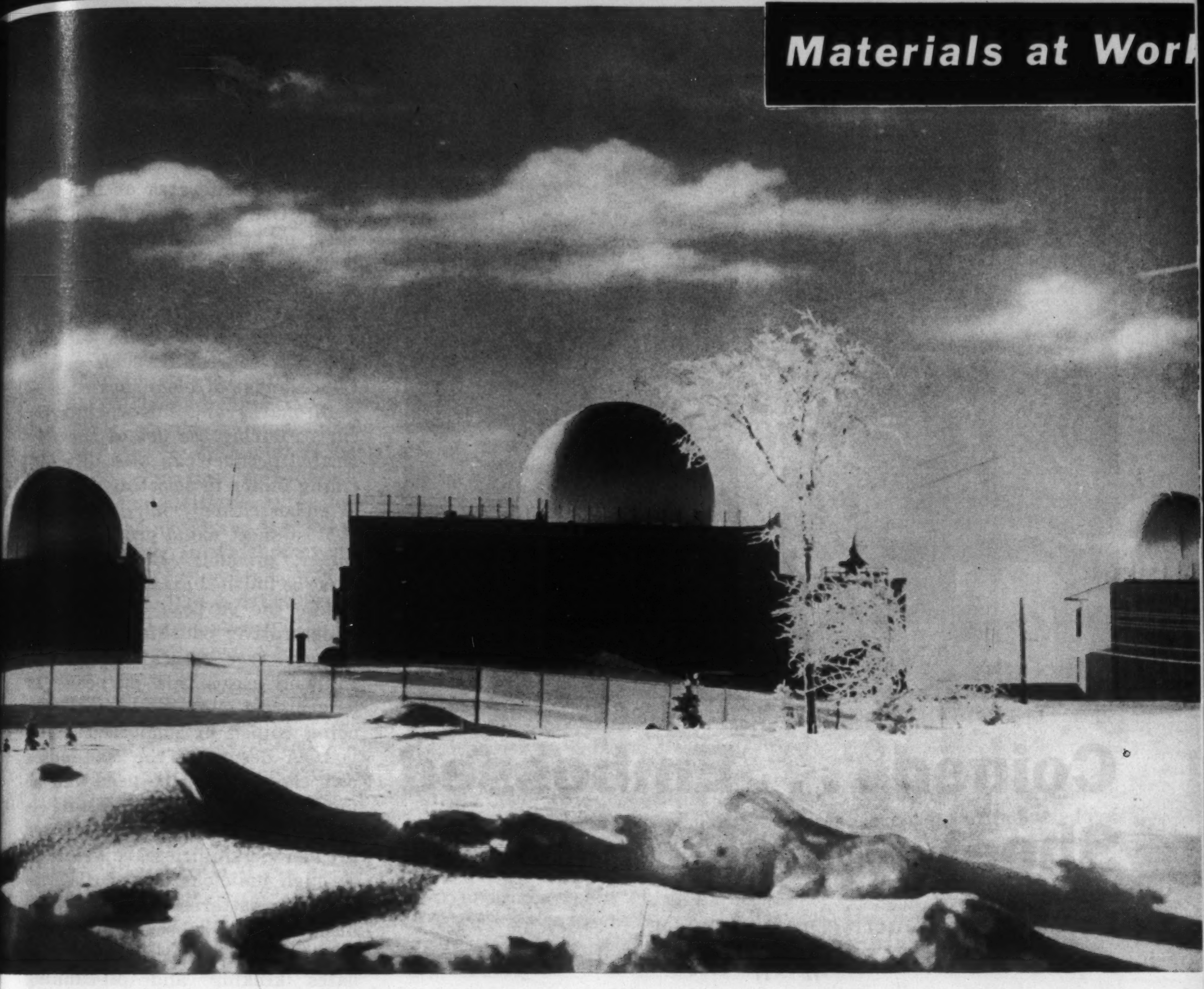
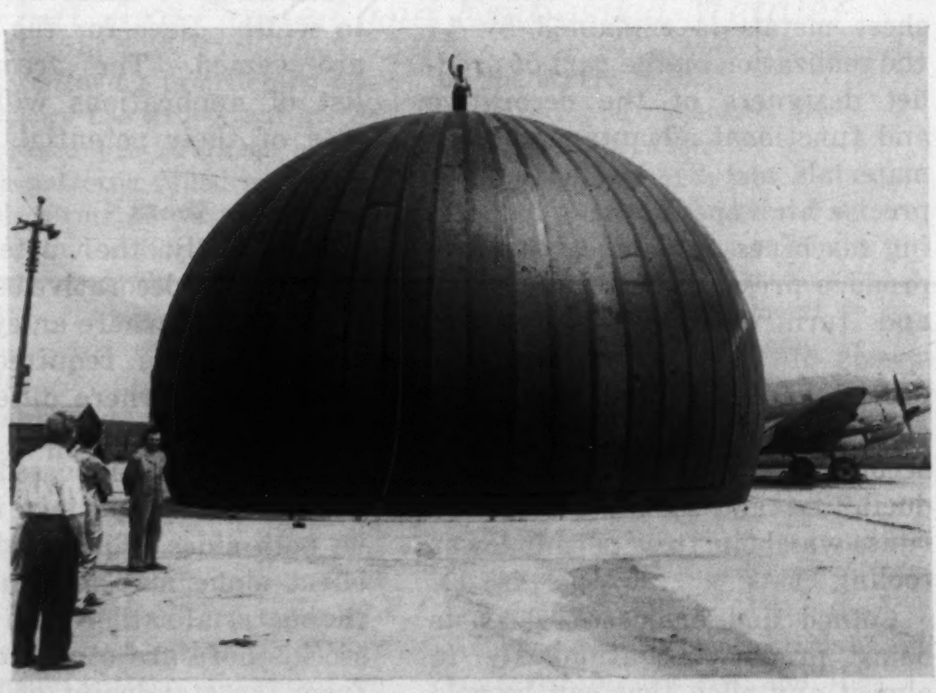
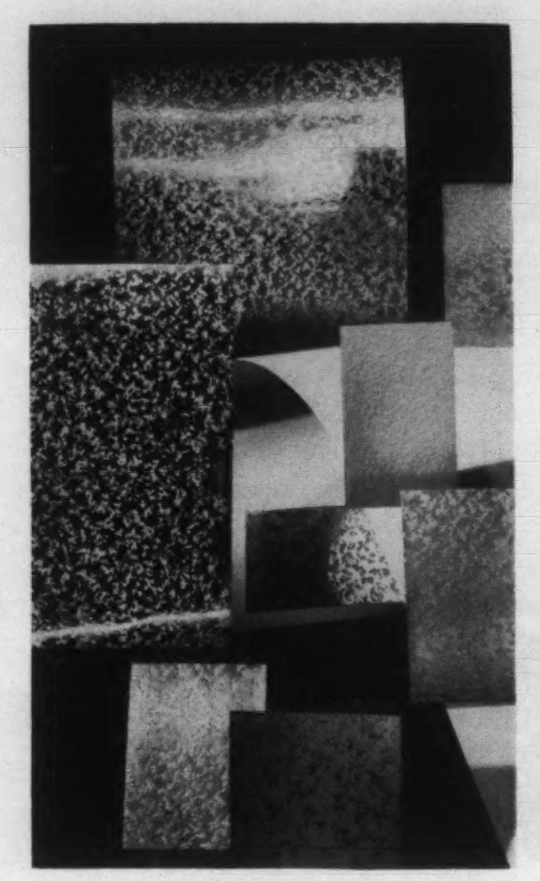
E. B. FitzGerald, "Photo-oxidative Degradation of Alkyd Films", pp. 65-76.
Roger L. Saur, "Photochemical Degradation of Automobile Lacquers", pp. 61-65.

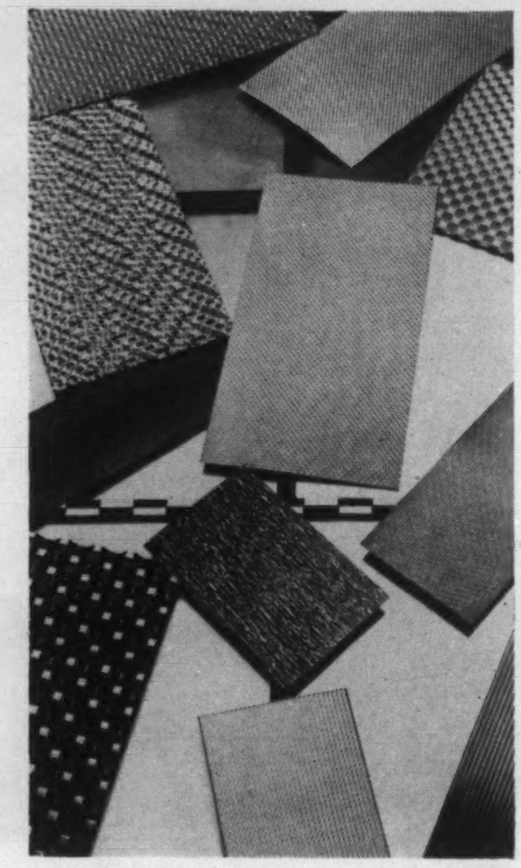


Glass and neoprene in air supported radome



Made of single-ply neoprene-coated glass fibers and supported only by air, these radomes form the first unit of a chain of radar stations which will parallel the U.S.-Canadian border. Approximately 54 ft in diameter, 36 ft high and mounted on a 50 ft diameter base, the domes require no internal supporting structure. Air pressure required to support them is low enough so that commercial ventilation blowers can be used to simultaneously support and ventilate the structure. Developed by Cornell Aeronautical Labs for G-E, the domes withstand wind velocities up to 125 mph and temperatures ranging from —65 to 140 F. They resist weathering and cause no loss in transmission and reception of radar signals.





Coined . . . . Embossed Sheet Metals

Use them for attractive finishes or for better mechanical properties

by M. W. Riley, *Associate Editor, Materials & Methods*

■ Recent increase in production and use of coined and embossed sheet metals is explained by 1) the realization on the part of product designers of the decorative and functional advantages of the materials and 2) development of precise high-speed rotary embossing machines—machines that can produce pressures up to 100 tons and turn out the material at speeds of 50 to 1000 fpm. Improved hardening techniques for engraved rolls result in greater accuracy of pattern, better reproducibility, and longer production runs, which in turn permit lower tooling costs.

Coined and embossed sheet is being produced continuously in almost any alloy that can be cold rolled, in thicknesses ranging from foil to almost plate gage, and in varying widths ranging from strip to sheet up to 50 in. in width. Uses for the materials are varied. The accompanying list of applications will give an idea of their potential.

Why use them

Essentially the materials are intended for decorative use. Coined sheet is used where an eye-appealing surface is required on one side only, or where different patterns are desired on the two sides of the sheet. Embossed sheet is used where the pattern is desired on both sides. Though decorative effect alone may advocate use of the material rather than flat sheet stock, there are other advantages from the standpoint of both production and product design.

Scratching or marring flat sheet metals during shipping and production handling can result in high rejection rates or finishing costs. Use of embossed or coined sheet or strip can materially reduce these costs since blemishes are not as apparent on the material. An accompanying photo shows the effectiveness of patterns in concealing such marks. Concealment of blemishes such as scuff marks and fingerprints incurred during the use of the fabricated product can also be a deciding factor in selecting a coined or embossed material.

Most sheet metal products, consumer products in particular, must be finished after fabrication. Where the purpose of the finish is decorative, polishing, brushing or some type of coating is used. In many cases this purpose can be achieved more economically by using coined or embossed material. A design of the customer's own choosing can be used and no finishing other than cleaning is necessary after fabrication. Even broader possibilities are available through judicious use of coatings over the patterns. These will be discussed in a subsequent section.

Pattern in sheet metals eliminates kinking and oil-canning which can occur if flat sheet metal is used over a large area. They also diffuse light, eliminating harsh highlights on polished materials, or telltale highlights on distorted materials.

Mechanical properties

The amount of cold working during coining or embossing is dependent on the type and depth of pattern, and the type and thickness of the sheet metal. It seems to be the concensus that coining produces little more effect on mechanical properties of the sheet than the final pinch roll operation in cold rolling sheet or strip. On the other hand, embossing definitely changes mechanical properties of the sheet or strip. Actually, there is relatively little sound engineering data available on degree of change in mechanical properties brought about by embossing action. Most of the information available was developed by Rigidized Metals Co. The accompanying tables indicate the degree of change in flexural rigidity and tensile properties for some aluminum alloys, and stainless and low carbon steels. Load-deflection curves are also shown for aluminum and titanium. These data were gathered on three standard patterns which the company has found provide optimum results in strengthening the material. It should be emphasized that the degree of change in mechanical properties will depend on individual patterns, types and thickness of metal and the design of the product in which they are to be used. It is therefore difficult to generalize. These data are presented to give an idea of the results that can be expected.

Improvements in mechanical properties due to embossing are due to both cold working the metal and the "girder" effect of design of pattern. The pattern can be so designed as to strengthen the material in one direction without loss of strength in a perpendicular direction, or it can be applied to strengthen the sheet in two or more directions. The amount of metal displacement can be regulated to achieve required combinations of structural properties. Radii of pattern lobes can be increased to improve transverse bending fatigue-stress values, or they may be reduced to secure maximum flexural rigidity.

It is impossible to make a flat prediction that use of embossed material will permit reduction of sheet thickness in all cases. According to Rigidized Metals Co., however, in most applications where embossed stainless steel replaces flat stainless, a reduction of one whole gage size is practical, and in many cases the change permits reduction by two gage sizes, while maintaining equivalent or greater strength and rigidity. Austenite stainless steels are particularly suitable for strengthening by embossing, due to their high work hardening rate. Possibilities of reduction in gage of metal should be considered carefully with the material supplier in the light of individual applications.

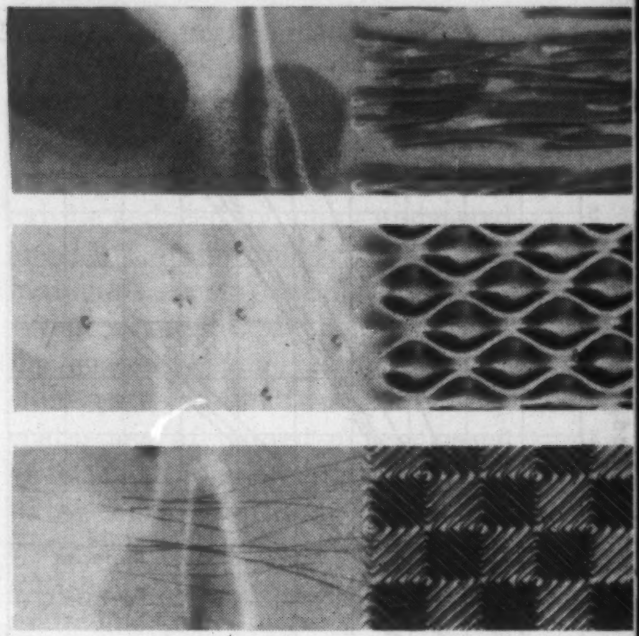
Fabrication and design

In general, fabricating of coined and embossed metals can be carried out with standard tooling used for flat sheet metals. Depending on the alloy used, the materials can be blanked, punched, formed, stamped, drawn moderately, roll-formed, lock seam joined, electrically welded, riveted, automatic hydrogen-welded, cycleweld bonded, and soldered. Some modification of techniques are recommended for fabricating embossed materials. In forming, die clearance should be adjusted for cross-sectional thickness rather than for metal thickness. Bend radii should be at least twice the cross-sectional thickness of the material, though sharper bends can be obtained with deeper patterns if bend lines fall along apexes of the design. For severe bends, axis of bend should run at right angles to pattern direction.

Depth of draw possible is debatable and will depend on the pattern and design of the product. Draws that are too deep will result in some distortion of the pattern and occurrence of localized stresses. No pattern distortion is likely to occur in draws of 1 in. and under.

In joining materials, patterns can be matched along joining edges. For resistance welding, copper wire braid can be laid between electrode and embossed pattern to form a nest for pattern and electrode. If pattern distortion at the weld is not objectionable, the metal can be flattened along the joining line.

Depth of pattern depends on type of effect desired, and the type and thickness of material formed. In coined materials, pat-



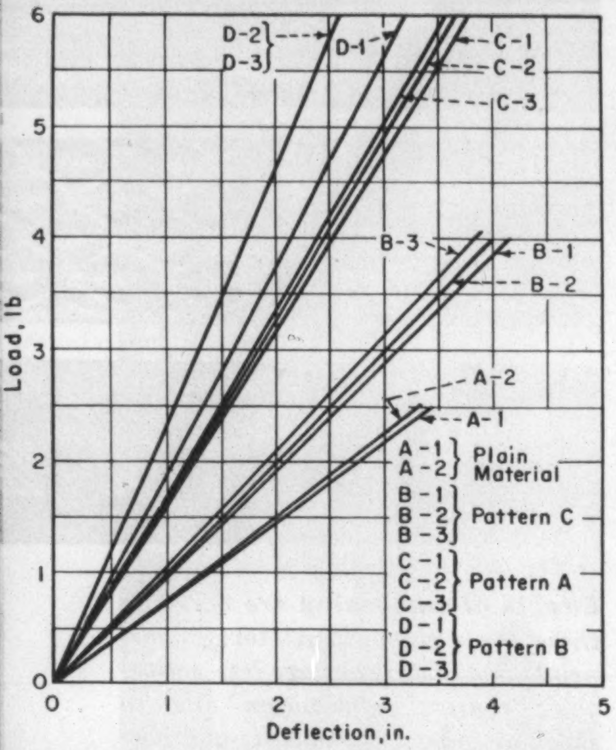
Effects of embossing *are shown in these three samples. At top, fingerprints and distortions are less noticeable; center, deformation due to shock or impact is reduced; and bottom, scratches are concealed.*
(Rigidized Metals Corp.)

What Are Coined and Embossed Metals?

A confusing proprietary terminology has grown out of the increased use of sheet metals with patterns rolled into them. Such terms as *patterned*, *textured* and *rigidized* have been widely used. To generically describe the materials in this article, the terms *coined* and *embossed* are used. Coined sheet refers to sheet metal which has a pattern impressed on only one side of the material, i.e., there is a male or female pattern on one side, but no matching male or female on the other. Embossed sheet refers to sheet metal which has a male pattern impressed on one side and a matching female on the other.

Coined and embossed sheet or strip is produced by a cold rolling operation in which the desired pattern is engraved on hardened forged steel rolls. As the sheet or strip passes between the rolls the metal is conformed to the pattern. In rolling coined sheet or strip, one of the rolls has the pattern engraved in it while the other is either smooth or has another pattern engraved in it to produce different patterns on either side of the sheet. In embossing sheet or strip, the rolls are matched, i.e., the male engraved in one roll and the matching female in the other.

How Embossing Improves Properties



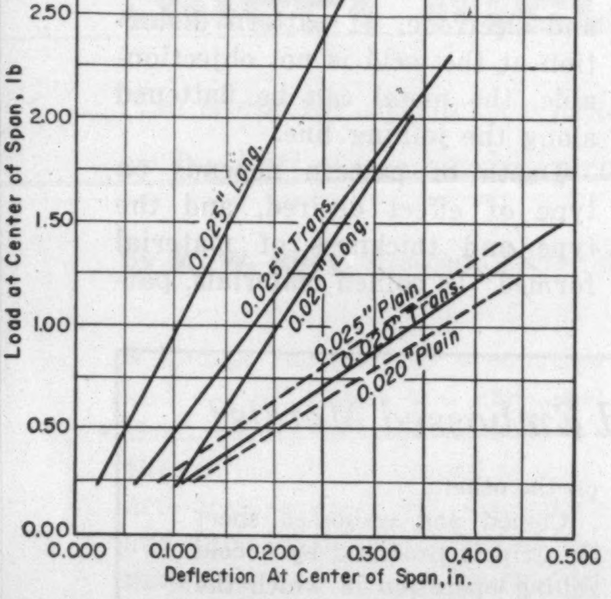
Note improvement in bending characteristics of titanium sheet brought about by embossing with three sample patterns shown at bottom of page. *(Rigidized Metals Corp.)*

FLEXURAL RIGIDITY OF EMBOSSED VS PLAIN SHEET

Material		Average EI, sq in. lb	Corrected EI[1]	Weight, g	Increase in EI, sq in. lb
ALUMINUM					
2024–0	Plain	7.69	7.24	4.693	
	Embossed (Pattern B)	15.07		4.601	7.83
2024–T	Plain	7.18	7.16	4.599	
	Embossed (Pattern B)	13.90		4.596	6.74
STAINLESS STEEL					
17–7 PH (full hard)					
	Plain	14.41	14.29	11.809	
	Embossed (Pattern B)	25.44		11.770	11.26
CARBON STEEL					
SAE 1010	Plain	74.36	59.0	20.130	
	Embossed (Pattern C)	67.4		18.655	8.4

[1] ***EI of flat sheet of material having a weight equal to average weight of embossed sheet. It is assumed that the value of EI varies as the cube of weight of flat sheet.***

Source: Test Data, Physical Properties of Rigid-Tex Metals, Rigidized Metals Corp.



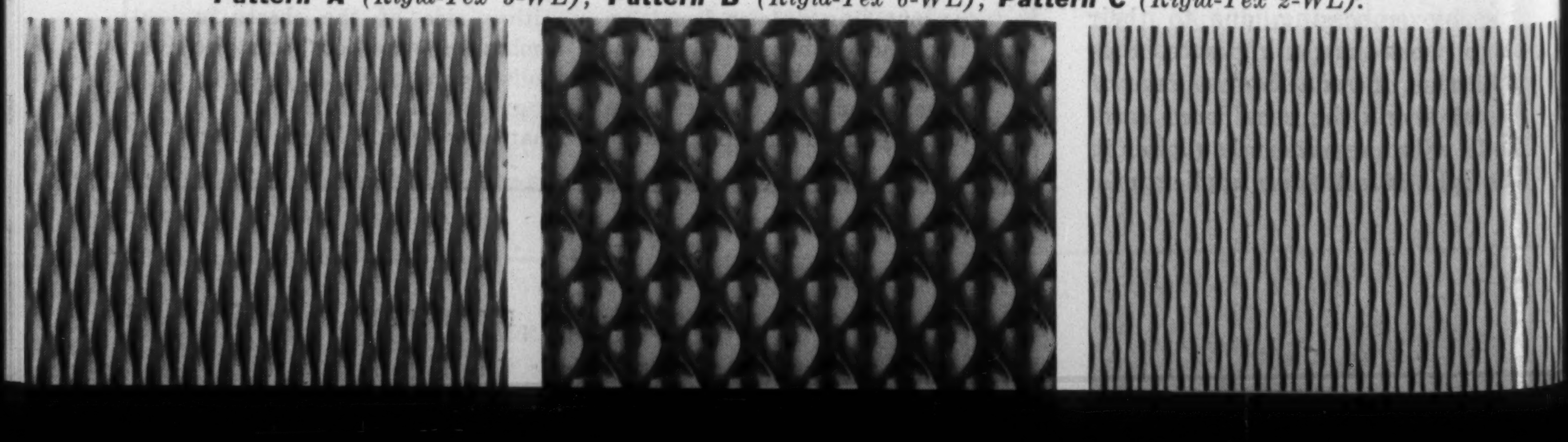
Load-deflection curves for 0.020 and 0.025 in. thick 2024-0 alclad aluminum. Unembossed sheet is shown by dotted lines. Solid lines show bending characteristics both transverse and longitudinal for sheet embossed with pattern B, shown below. End point of each curve represents load at which permanent set of 0.010 in. occurs. *(Rigidized Metals Corp.)*

TENSILE PROPERTIES OF EMBOSSED VS PLAIN METALS
(0.025 in. thick specimens)

Material		Yield Strength, psi	Tensile Strength, psi	Elong in 2 in., %
302 STAINLESS STEEL				
Longitudinal	Plain	35,165	95,800	62.5
	Embossed (Pattern A)	89,110	123,380	29.5
Transverse	Plain	31,100	96,460	60.5
	Embossed (Pattern A)	43,390	100,310	24.0
430 STAINLESS STEEL				
Longitudinal	Plain	39,640	76,730	24.0
	Embossed (Pattern B)	69,030	84,120	14.5
Transverse	Plain	49,550	78,450	25.0
	Embossed (Pattern B)	Not obtained	83,410	17.0

Source: Test Data, Physical Properties of Rigid-Tex Metal, Rigidized Metals Corp.

Pattern A *(Rigid-Tex 5-WL)*; **Pattern B** *(Rigid-Tex 6-WL)*; **Pattern C** *(Rigid-Tex 2-WL)*.



tern depth generally averages 0.007 to 0.008 in., though it may range from 0.002 to 0.015 in. Embossed materials, of course, have a wider range of pattern depths extending into corrugated patterns. Interesting effects can be obtained by altering the depth of patterns in specified areas resulting in sheets with two overall patterns.

Finishes

The patterned characteristic of coined and embossed sheet metal permits an extremely wide variety of decorative coating possibilities. In some cases, coatings can be more economically applied before coining or embossing, depending on flexibility of coating, and depth and severity of pattern radii. Several companies supply sheet or strip pre-plated with various common electroplates such as zinc, copper or nickel. Other possibilities include dyed anodized coatings on aluminum, a wide range of organic type paints, lacquers and varnishes, and porcelain enamel. Interesting effects can be achieved by applying the coating, then polishing the high areas of the pattern, producing a two-tone effect.

Recently there has been increasing interest in the use of porcelain enamel on coined and embossed stainless steels. Though coating stainless steel is not a normal procedure, it does have advantages in this use. Coined or embossed stainless can be porcelain enameled and polished, leaving some areas covered and others uncovered. These uncovered areas will not corrode, as would carbon steels. Also, stainless steels coated on one side only, can withstand relatively high firing temperatures without warping. Extensive use of this type of material is expected in the architectural field, for curtain walls.

Costs

The costs of coined and embossed materials are higher than those of flat sheet or strip. Cost will depend on the pattern desired, material in which it is rolled and production quantity. Generally the extra cost over and above the base price of the flat sheet or strip will run from $0.01 to $0.08 per lb.

In supplying coined or embossed materials, various companies operate in different ways. Many carry some standard patterns in stock. The most common method of purchasing the materials is for the customer to specify or design the pattern. The rolls are engraved to his specification and they then belong to him, and the supplier custom-rolls the material for him.

In deciding whether to use these materials or not, the designer and engineer should realize that though they cost more than flat stock, slight additional costs are in many cases balanced out by advantages in use. Where gage can be reduced by using embossed sheet or strip, the actual initial materials costs may be lower. When scratches or blemishes on flat material cause a high rejection rate or increase finishing costs, use of coined or embossed sheet or strip can reduce or eliminate these additional costs. In some cases, there is no way of getting around the fact that the materials will increase the cost of the product. However, aesthetic or sales considerations will many times dictate the use of the material in spite of its cost.

Acknowledgements

The author would like to express his appreciation to personnel of the following companies and organizations for their helpful assistance in the preparation of this article:

Aluminum Co. of America
American Iron and Steel Inst., Committee of Stainless Steel Producers
Eastern Brass & Copper Co., Inc.,
Kaiser Aluminum and Chemical Sales, Inc.
Modern Engraving & Machine Co.
Pittsburgh Steel Co., Thomas Strip Div.
Reynolds Metals Co.
Rigidized Metals Corp.
Sharon Steel Corp.
Sun Steel Co., Special Products Div.

Partial List of Applications for Embossed Metals

- Aircraft flooring
- Airplane stair step
- Aircraft heaters
- Juke box grilles (perforated)
- Organ grilles (perforated)
- Engine shrouds
- Ammo boxes
- Door facing
- Wall panels
- Interior building panels
- Kick plates
- Shingles
- Honeycomb panels
- Wainscotting
- Store front
- Display cabinet trim
- Electronic instruments
- Electronic boxes
- Electric transfer cases
- Wrought iron furniture
- Table tops
- Casket trim
- Funeral car trim
- Automobile scuff plates
- Subway cars
- RR car trim
- Truck body panels
- Racks for pots and pans
- Gas pumps
- Cabinet trim
- Chutes
- Drying tray
- Dresser set trim
- Lockers
- Flower boxes
- Engine assembly mount
- Control panels
- Grilles (perforated)
- Press plates
- Top automatic dish washer
- Name plates
- Switch plates
- Air heaters
- Fishing lures
- Conveyors
- TV chassis
- Radio grilles (perforated)
- Sign background
- Sign letters
- Telephone booth trim
- RR car interior
- RR car seat backs
- Auto trailers
- X-ray unit covers

Electrical and electronic parts,
filters,
high temperature parts,
reinforced plastics,
are uses of

Four Inorganic Papers

	ASBESTOS	MICA	GLASS	CERAMIC
Ten Str, psi	45	180	145	14
Thickness, in.	0.003	0.004	0.007	0.024
Density, g per cc	0.340	0.75	0.24	0.20
Porosity–Gurley, sec	21	45	2.4	2.2
Mullen Burst, psi	1	5	1	1
Elmendorf Tear No.	5	5	8	6
Heat Distortion Temp, F	964	896	1094	2102
Dielectric Constant at:				
60 cps	3.4	1.19	1.073	1.08
1000 cps	2.6	1.19	1.072	1.08
10,000 cps	2.1	1.19	1.071	1.08
Power Factor, % at:				
60 cps	28	0.15	0.02	0.02
1000 cps	27	0.14	0.02	0.02
10,000 cps	17	0.13	0.02	0.02
Dielectric Loss Factor at:				
60 cps	0.7	0.002	0.0002	0.0002
1000 cps	0.06	0.002	0.0002	0.0002
10,000 cps	0.6	0.002	0.0002	0.0002
Volume Resistivity, ohm-cm	8×10^{10}	$>10^{12}$	$>10^{12}$	$>10^{12}$

These papers contain neither binders nor fillers.

by Thomas D. Callinan, *U. S. Naval Research Laboratory*

■ In 1940 no papers made entirely from inorganic components were commercially available. Within the last fifteen years, four such papers have become available commercially in various modifications from at least seven manufacturers supplying the wire and cable, reinforced plastic, electrical and filtration industries.

The presently available items are made from such natural fibers and flakes as asbestos, bentonite and mica, and from the man-made glass, silica and ceramic fibers. Still in the developmental stages are papers made from synthetic mica, flake glass and metal fibers. Besides, research men are eyeing keenly the possibilities of varying the chemical compositions of the fibrous glasses with the idea of modifying radically the properties of the present items.

The inorganic papers do not have the strength of book paper or wrapping stock, but since most of their applications necessitate impregnation and coating with resins and plastics, the lack of strength has not prevented their exploitation in electric motors, air-cooled transformers and in electric capacitors. Also, filter papers as commonly employed are usually backed by wire screens or perforated plates and consequently the low mechanicals of inorganic papers have not prevented their use in the laboratory or in plant operations.

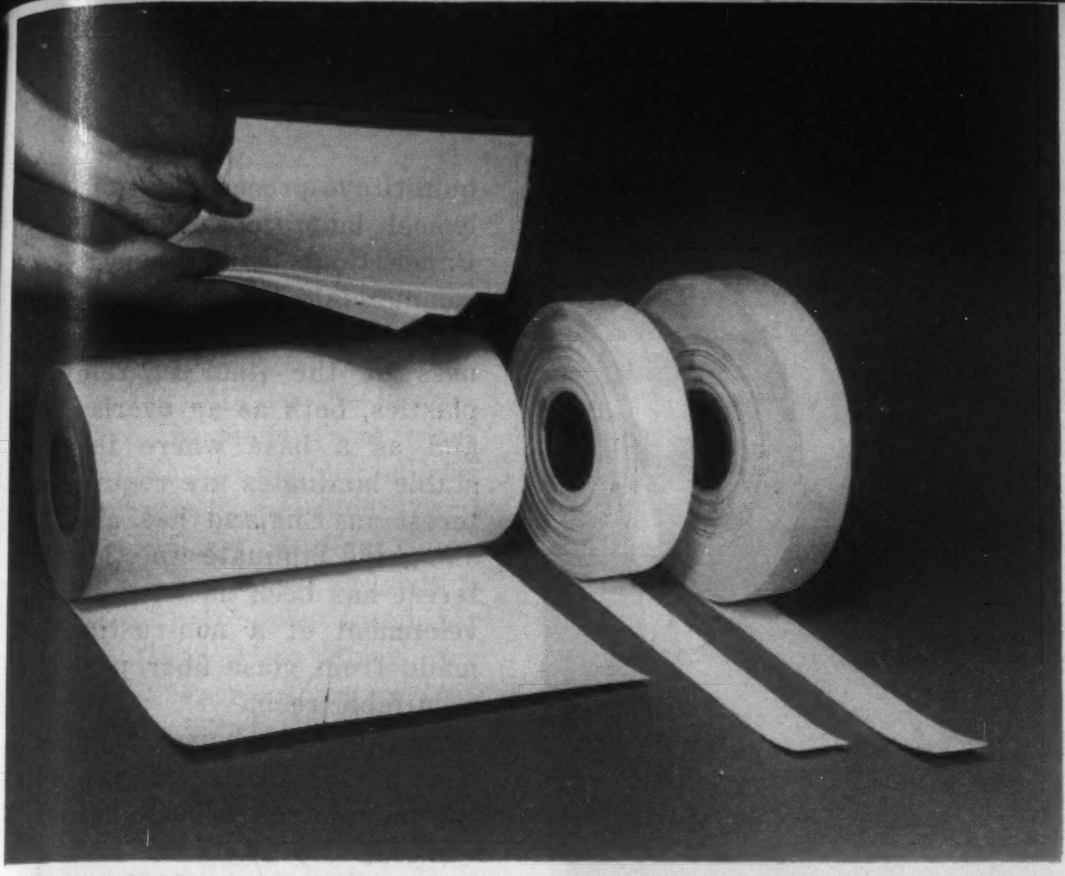
Broadly considered, there are two types of inorganic papers: 1) those which are porous, soft and made from fibers, and 2) those which are dense, hard and made from flakes. The fiber base materials are adaptable to filtration applications, while the flake base items are used where impenetrability is a necessity, such as in high voltage engineering uses.

The accompanying table lists the important mechanical, physical and electrical properties of four inorganic papers. The properties are for papers containing no binder or filler. Incorporation of a filler or size modifies the papers' characteristics appreciably, tensile strength and density increasing while porosity decreases. Because no organic binders are used, the materals in the table are noninflammable and withstand temperatures over 840 F without decomposition or change.

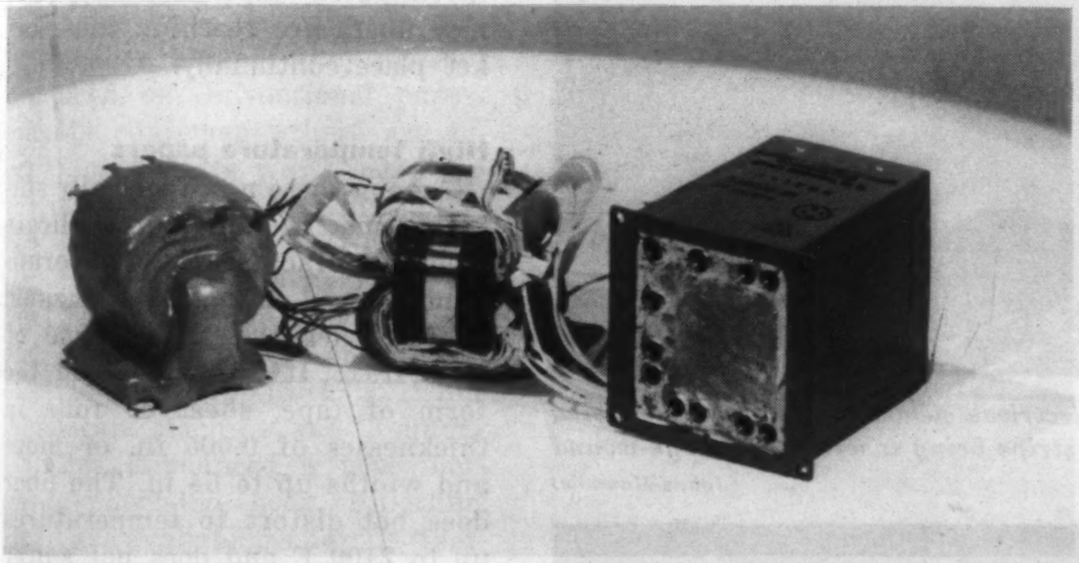
The basic requirement for the successful commercial production of a paper is that the fibers or flakes remain suspended in water and can be drained rapidly on the fast moving wire of a conventional paper machine. One approach has been to use fibers which are of colloidal dimensions (0.250 microns) while another has been to use detergents to keep the paper making stock separated.

Asbestos base papers

Chrysotile asbestos, being easi-



Ceramic paper *(aluminum silicate), available in sheets and rolls in thicknesses of 0.020, 0.040 and 0.080 in., retains its properties and form up to around 2100 F.* *(Carborundum Co.)*



Glass paper *made from superfine fibers reinforced with Teflon was used in these filament and rectifier transformers and resulted in a 30% reduction in size.* *(American Machine & Foundry Co.)*

ly fibrillated was the first to yield a 100% inorganic paper when 20% bentonite was added to the stock. Incidentally, bentonite itself has been cast into a continuous sheet which is flexible when thin and totally inorganic.

The asbestos base papers are manufactured by Johns-Manville under the trade name of Quinterra and by General Electric Co. under the name Terratex. An entire line of such papers exists, with or without binders, specifically for use in the electrical insulation trade. Thus, the material has been used successfully in Navy and marine cable manufactured to AIEE specification No. 45. Highly purified asbestos insulation is being used in fixed and variable resistors and in conjunction with mica splitting to insulate Nichrome wire heating elements in water heaters.

In new developments such as miniature transformers, a 30% reduction in weight was realized when asbestos based papers were employed in Class-B operating 3000 watt transformers. Terratex has been successfully used as turn insulation in arc-welding transformers. It has been recommended, when suitably impregnated with colloidal silica, as a grid-spacer in electronic tubes.

Attention lately has been focused on improving the quality of asbestos papers by "opening" the fibrous bundles, thereby removing entrapped undesirable magnetite by heat treating the raw fiber and by blanding the asbestos with synthetic fibers such as glass. The papers prepared are suggested as base sheets in reinforced plastic laminates by Raybestos-Manhattan, Inc., and intensive studies are being conducted in government and industrial laboratories on the items.

Mica paper

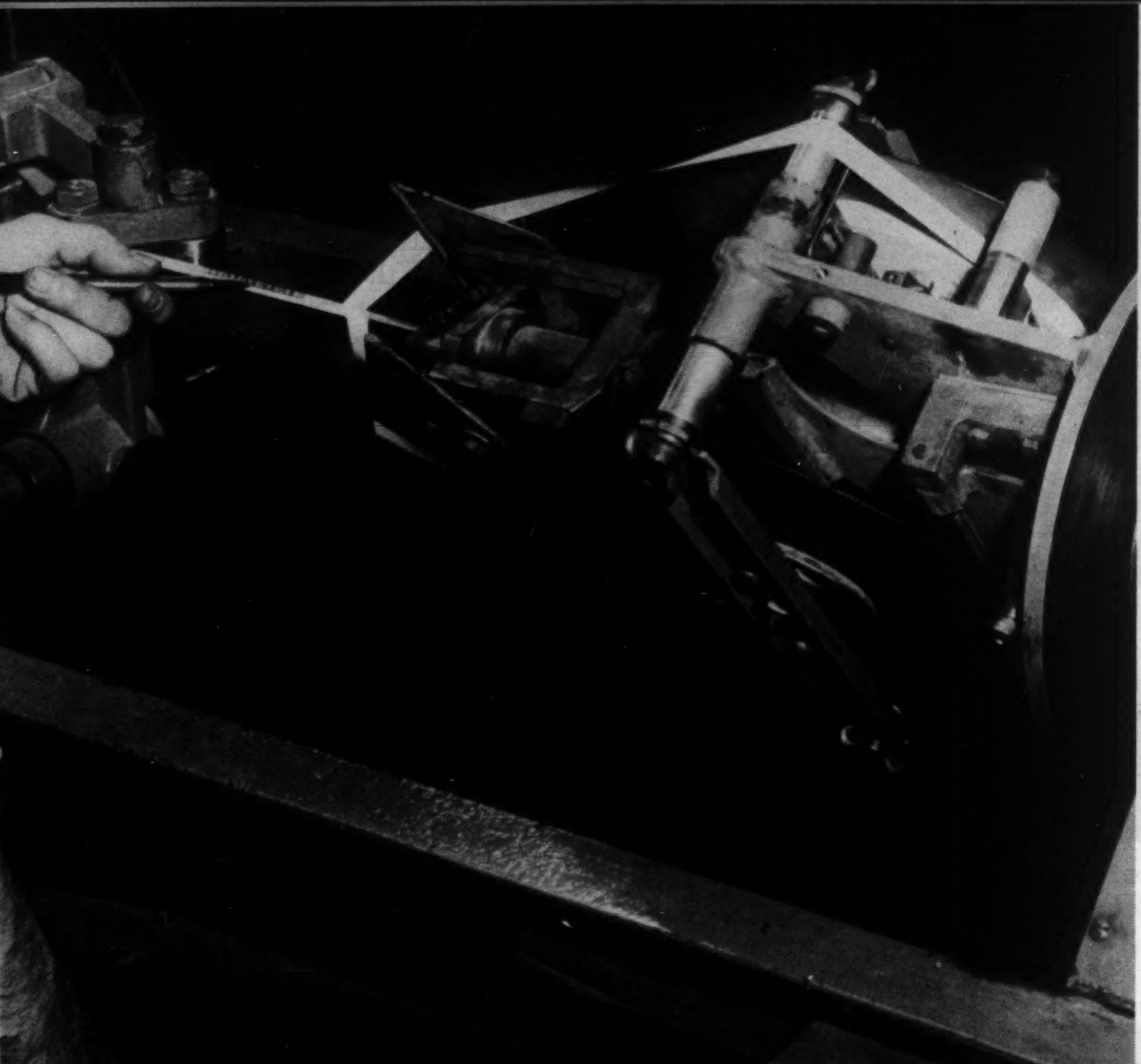
Produced and developed for many of the same markets as asbestos paper, there are three manufacturers of mica paper in the United States and one in Europe. It is manufactured commercially by Samica Co., General Electric Co. and Integrated Mica Co. It has found uses as a substitute for conventional "built-up" mica as slot armour, wedges and segment insulation in generators and motors and as the dielectric separator in high voltage, high temperature condensers.

The material is available in thicknesses of 0.002 in. and thicker, and in continuous sheets 40 in. wide, supplied in jumbo rolls suitable for slitting into tapes or cutting into sheet for laminating purposes. The product in its totally inorganic state is a silvery sheet having a metallic lustre and rattle. On being impregnated with resin, it assumes a varnished appearance.

Since it can be manufactured in this country from scrap-mica and run-of-the-mine muscovite, it is considered, justifiably, to have helped the logistics situation greatly. Except for 5 to 10% of the mica requirements, it will apparently satisfy our mica needs.

Glass fiber paper

Differing from mica and asbestos paper in that it is highly porous, nonhydrating and entirely man-made, the glass fiber papers have been used successfully as filters for aerosols and other air-borne particulates and in the



Mica paper *finds wide use in the electrical field. Top, mica tape being wrapped on wire. Bottom, pre-cut mica strips being inserted into edge-wound field coil.*
(Johns-Manville)

quantitave procedures of the analytical laboratory. The Hurlbut Paper Co., which pioneered the commercial development of this paper, has disclosed the usefulness of the item in reinforced plastics, both as an overlay sheet and as a base where thermally stable laminates are required. Interest in England has also been along the laminate line. Much interest has been shown in the development of a non-rusting pipe made from glass fiber paper and a suitable resin.

In these developments glass fibers having diameters of 0.16 to 1.5 microns have been used successfully depending on the degree of porosity required, the coarser fibers yielding the more porous products. A host of glass compositions in fibrous form have been investigated experimentally, and new fibers are reaching the market place continually.

High temperature papers

Among these new thermally stable items is aluminum silicate fiber manufactured by Carborundum Co. and sold as an inorganic paper under the trade name of Fiberfrax. It is available in the form of tape, sheet or rolls in thicknesses of 0.005 in. or more and widths up to 54 in. The fiber does not distort to temperatures up to 2100 F and does not suffer the loss of water in the manner of asbestos or mica on heating. Other manufacturers of ceramic fibers are Johns-Manville and Babcock and Wilcox Co.

Another high temperature paper developed specifically for high temperature uses is silica paper, having a melting point of about 3090 F and manufactured by the Hurlbut Paper Co. The fiber is produced by leaching ordinary glass fibers with acid followed by firing; they are available from the H. I. Thompson Co. and L-O-F Glass Fibers Co. The acid removes all the constituents of the glass except the silica in fibrous form from which the paper may be prepared on conventional paper-making equipment. Incidentally, because of the absence of boron in this thermally stable paper, it has been suggested for use in fields of neutron flux.

Recent developments

The most recent of the inorganic papers, still in the laboratory stage, is made from glass flakes. These are double pellicles approximately 1/4 in. square and 16 microns thick. Just as man-made glass, ceramic and silica fibers have been substituted for asbestos, these glass flakes are substitutes for mica paper. Actually, the qualities of the glass flake paper are different from its mica counterpart, being transparent and colorless rather than silvery and metallic in lustre. It is brittle and readily impregnated, yielding good laminates which will undoubtedly be exploited in regions of high temperature.

Finally, while not papers strictly so-called because they are not produced on conventional paper-making equipment, there are inorganic products which have entered the paper market in the last few years. Thus, L-O-F Glass Fibers Co. produces a "glass paper" from superfine fibers suitable for use in filtration and in dielectric tape applications, while American Machine and Foundry Co. has announced a new inorganic paper-like body, Fiberfilm. Both are available as porous, thermally stable items or as dense organic saturated films in continuous sheets. Because of their toughness and tear resistance, they have been suggested as cable coverings.

Inorganic vs cellulose papers

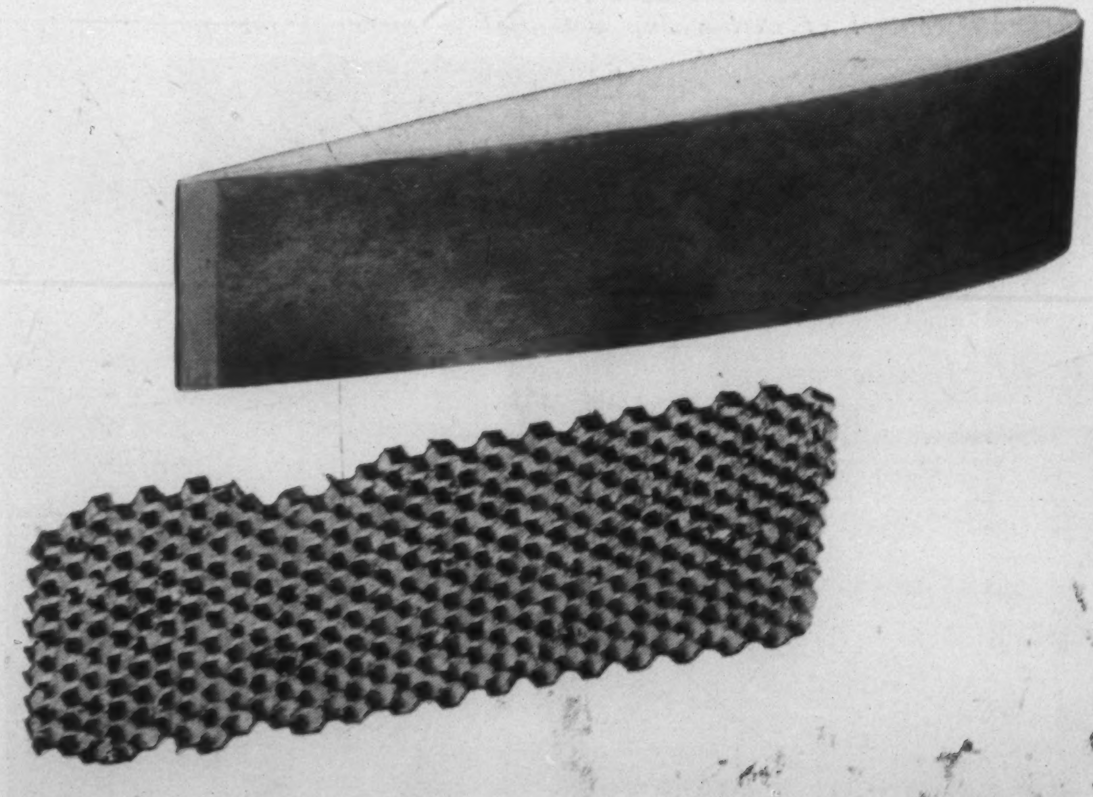
At the present time none of the 100% inorganic papers have sufficient strength to become formally competive with cellulose products. Their usefulness arises in supplying a need which the cellulose fibers are unable to fill. Thus, inorganic fibers are finer and hence more efficient as filters than cellulose fibers; again, cellulose burns while these inorganics do not.

Due to earnest study and work on the part of fiber producers, paper manufacturers and filter and reinforced plastic users, advances are being made rapidly. Glass fiber paper approaching the mechanical strength of newsprint has been produced recently, and the problem of printing on the inorganic paper is being resolved.

While still comparatively expensive as newsprint prices go, it is interesting to note the reduction in basic fiber prices of synthetics in the last five years. In 1950 a particularly good grade of paper-making glass fiber marketed at $20 per lb. Today, a comparably good grade is sold for $1.67 per lb. Considering that inorganic fibrous papers are only 25% as dense as cellulose papers, this means that on an equivalent square foot basis, the man-made fibers are 40-45¢ vs 6-10¢ for the least expensive ground wood pulps. Obviously, the better grades of cellulose pulp approach the price of the synthetics on this area basis. There seems little doubt that the difference in price will be narrowed. Even now the exploitation of these inorganic papers as permanent record papers is being seriously discussed. This will probably be the first move of these interesting new items into the more familiar uses of paper.

Asbestos based papers *are used in these three products. Center, experimental airfoil section; top, experimental rocket launcher tube composed of glass fiber warp interleaved with asbestos; bottom, honeycomb, low density, core material.*

(Raybestos-Manhattan, Inc.)

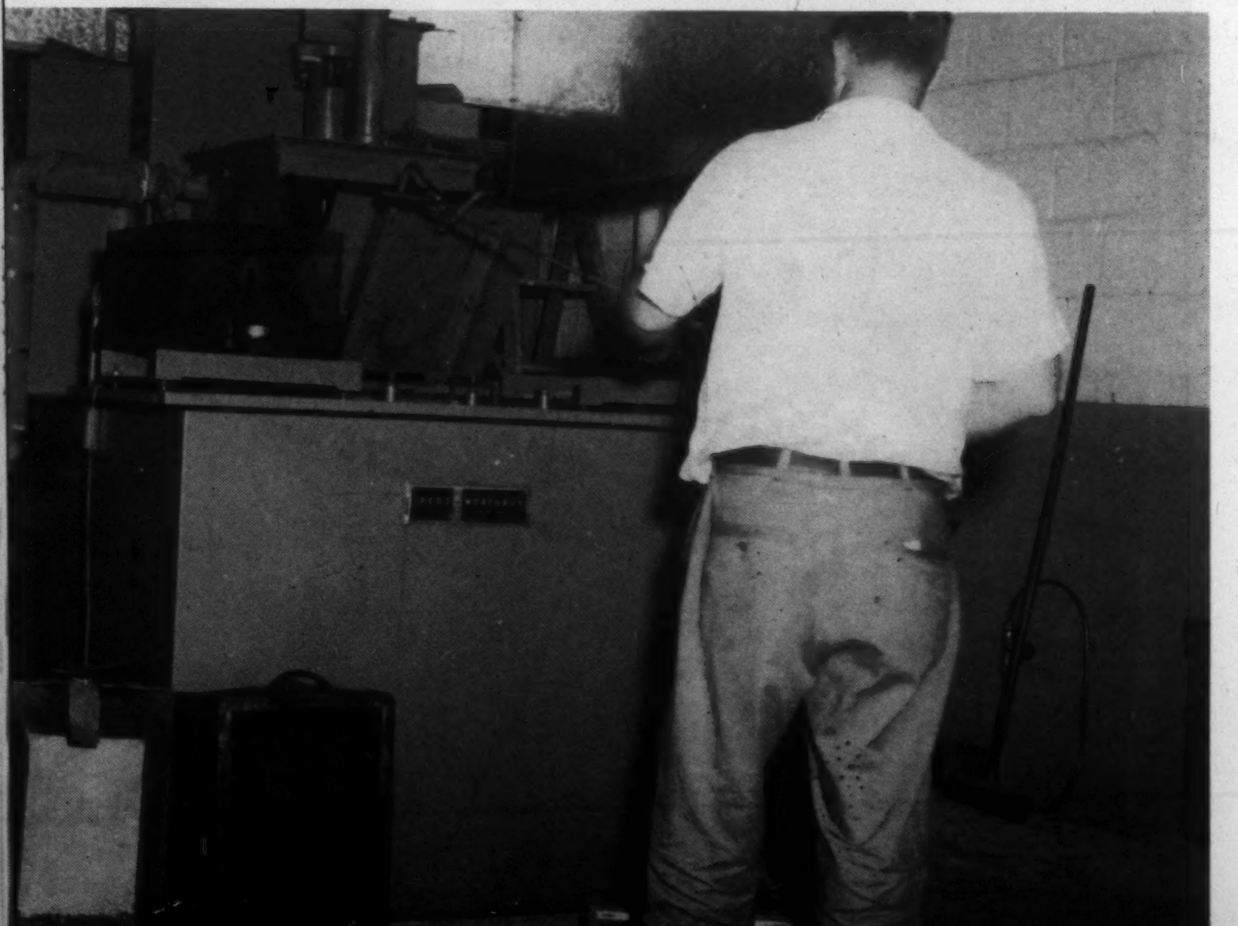


Loading *miniature train parts into a furnace at the A. C. Gilbert Co. for steam treatment. This treatment produces an attractive oxide finish on the parts.*

Iron Powder Parts Improved by Heat Treatment

Steam treatment improves properties and surface finish. Carburizing increases strength and hardness.

by **F. L. Spangler**, *Leeds & Northrup*



Furnaces *such as this are used for carburizing iron powder parts where accurate control of carburizing potential is essential for quality control.*

■ Many iron powder parts can function satisfactorily in the as-sintered condition. However, more exacting demands for some parts are leading to an increased use of subsequent heat treatments to meet the requirements.

In addition to conventional quenching and tempering which are used particularly for high density parts, steam treatment and carburizing are finding many applications.

Steam treatment produces an oxide coating not only on the surface of the compact, but also within the pores. As a result mechanical properties and corrosion resistance are improved.

Carburizing follows the procedures used for any low carbon steel but is somewhat more exacting in furnace requirements since the porosity of the compact introduces factors which must be more carefully controlled.

Both steam treatment and carburizing are being used at present in the production of instrument and other small parts.

Steam treatment

Steam atmosphere heat treatment produces a four-fold improvement in ferrous metal parts: 1) increases hardness and compressive strength, 2) increases corrosion resistance, 3) improves wear resistance and 4) imparts a uniform blue-black finish.

On iron powder parts, heating in a steam atmosphere in the temperature range 700 to 1150 F produces a tightly adherent controlled oxide coating on all exposed surfaces of the part. This film tends to fill the pores with oxide and substantially increases hardness. Consequently, the part has greater resistance to deformation under compressive loading. Tests have shown that sintered and steam treated compacts may have comprehensive yield points twice those obtained with a regular sintered compact. Typical are the shock absorber parts shown in a photograph.

After steam treatment, iron powder parts can be oil-dipped to increase resistance to corrosion. On bearing surfaces, for instance, where alternate heating and cooling results in condensation of moisture, the oxide-impregnated part retains oil sufficiently to resist the effects of moisture.

The hard oxide also provides a better breaking-in condition when starting up or wearing-in the part. When the oxide on the external surface particles wears away, the oxide in the pores continues to offer a network of hard wear resistant material.

Because iron oxide produces a uniform eye-appealing, blue-black color, miniature train parts such as wheels, couplings and similar components are steam treated. Experience has shown the oxide to be so tightly adherent that it does not crack or chip in handling or service.

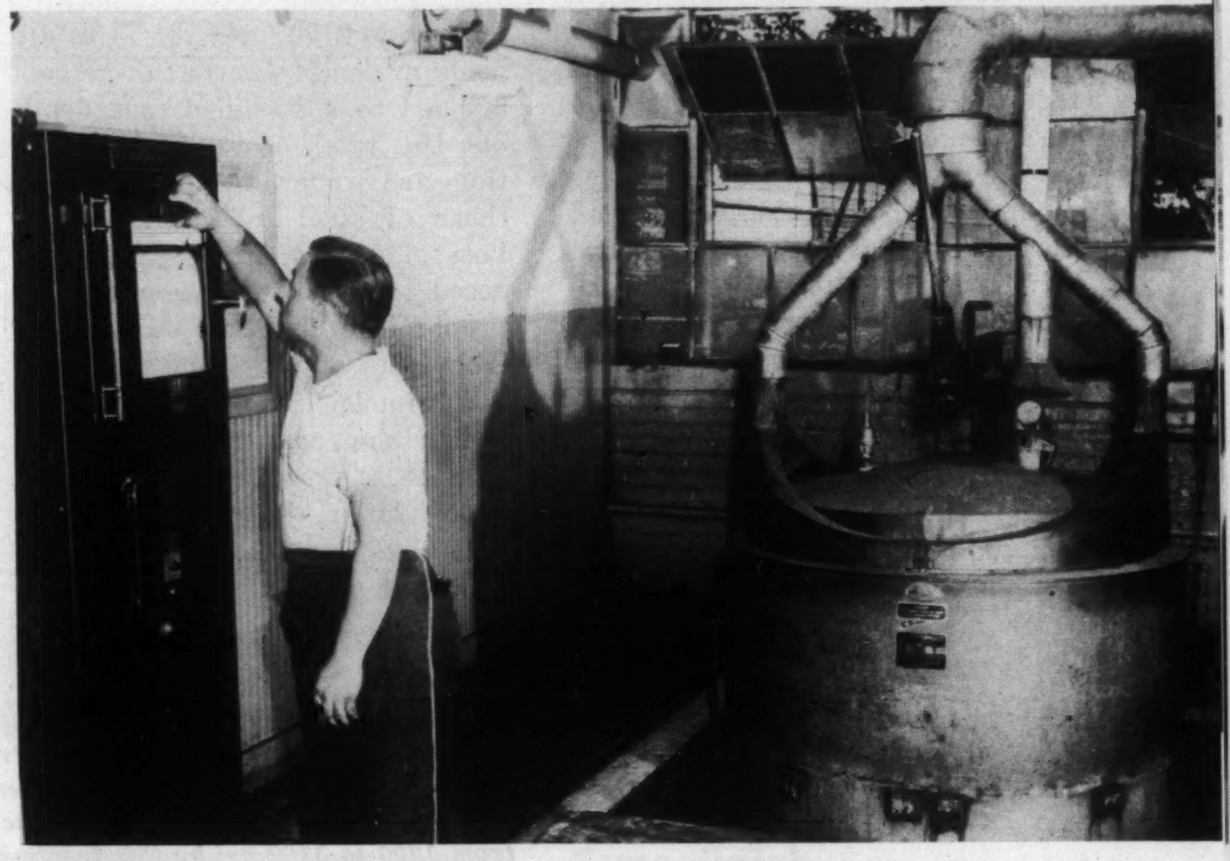
For steam treating, the equipment required consists of an airtight furnace preferably with forced circulation, a suitable temperature control system and a reliable source of steam. Excellent results have been obtained with L & N electric batch furnaces designed for forced circulation with the steam inlet at the bottom and exhaust at the top. For continuous production, 10 to 150 lb of steam per hr is required depending on the furnace size. Cost of steam treatment is only a few cents per lb of load.

Controlled atmosphere carburizing

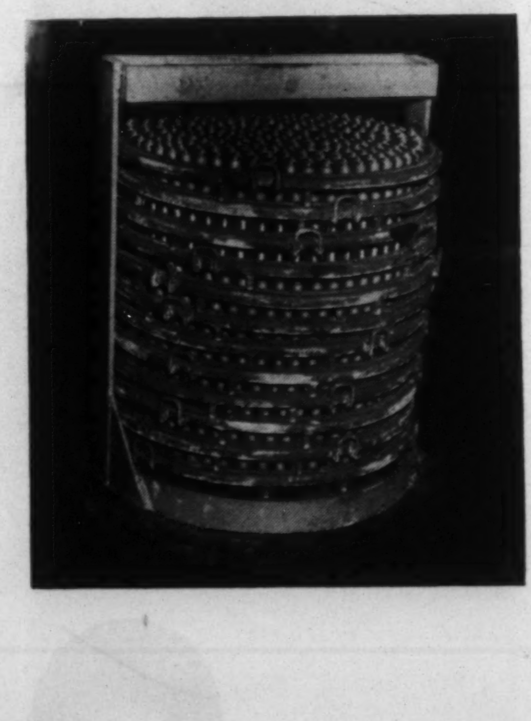
There are countless applications for metal powder parts where hardnesses higher than those obtainable with steam treatment are required. A common solution of this problem is adding graphite to the original powder mixture. With this method quality control is difficult since varying and unknown amounts of carbon are lost during the sintering operation and subsequent heat treatments.

A solution to this quality control problem is the addition of carbon by heat treating under precisely controlled conditions after the part has been formed and sintered. Only in the past two to three years has production-type equipment capable of controlling carbon potential and other variables become available.

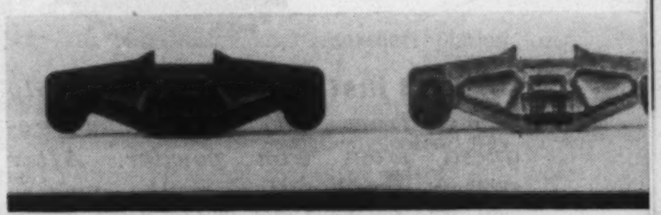
In general, there are three



Installing *a steam treating furnace directly in the production line saved nearly 3 hr handling time daily in the production of shock absorber pistons.*



Left: Shock absorber pistons *are steam treated to increase hardness and compressive strength.*



Above: Side frames for miniature trains *before (right) and after steam treatment. The blue-black finish produced by this treatment is tightly adherent and does not chip or flake off in service.* *(A. C. Gilbert Co.)*

classes of iron powder compacts: 1) low density [75 to 85%], 2) medium density [85 to 95%] and 3) high density [95% up]. High density parts are least difficult to heat treat because they respond much the same as wrought steel. Under properly controlled conditions it is possible to develop in such parts any desired physical characteristics by carburizing, carbon restoration or hardening and at the same time maintain the surface cleanliness, dimensional stability and close tolerances associated with metal powder parts.

Low density parts are most difficult to heat treat because their interconnected voids give them a sponge-like character. The heat treating atmsophere travels through these voids and acts on a very large surface area throughout the piece itself. In such cases too high carbon concentration and the resultant growth at edges and corners must be prevented by continuous accurate control of temperature and carbon potential of the atmosphere during the heating cycle. For example, low density business machine parts are being carburized at one foundry to a depth of 0.010 in. by heating at 1500 F for 2 hr in an atmosphere controlled at 0.8% carbon. During the transfer from the heating chamber to the quenching medium, the porosity of such parts normally tends to cause them to lose carbon rapidly. Resulting decarburization must be prevented by protecting the load from exposure to air during transfer from the furnace to the quench.

The problems and results obtainable on medium density parts fall somewhere between those of low and high density. Usually medium density parts can be carburized to a specified case depth but the rates of carbon penetration are somewhat greater than those of steel and high density. Loss of carbon, if the part is exposed to air before quenching, is proportionately more rapid than from high density compacts.

Equipment for performing such carburizing operations on a practical mass-production basis must have certain features.

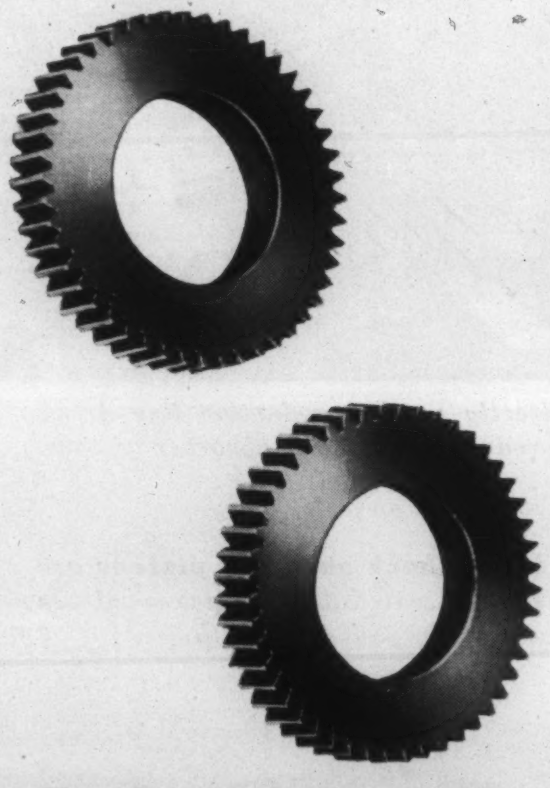
1. The furnace must be airtight and preferably have a means of forced circulation to insure uniformity.

2. Both temperature and carbon potential of the atmosphere must be measured directly in the heating chamber and under continuous automatic control.

3. A reliable source of carbon bearing gas must be provided.

4. Provision must be made for protecting work from exposure to air during transfer to the quench.

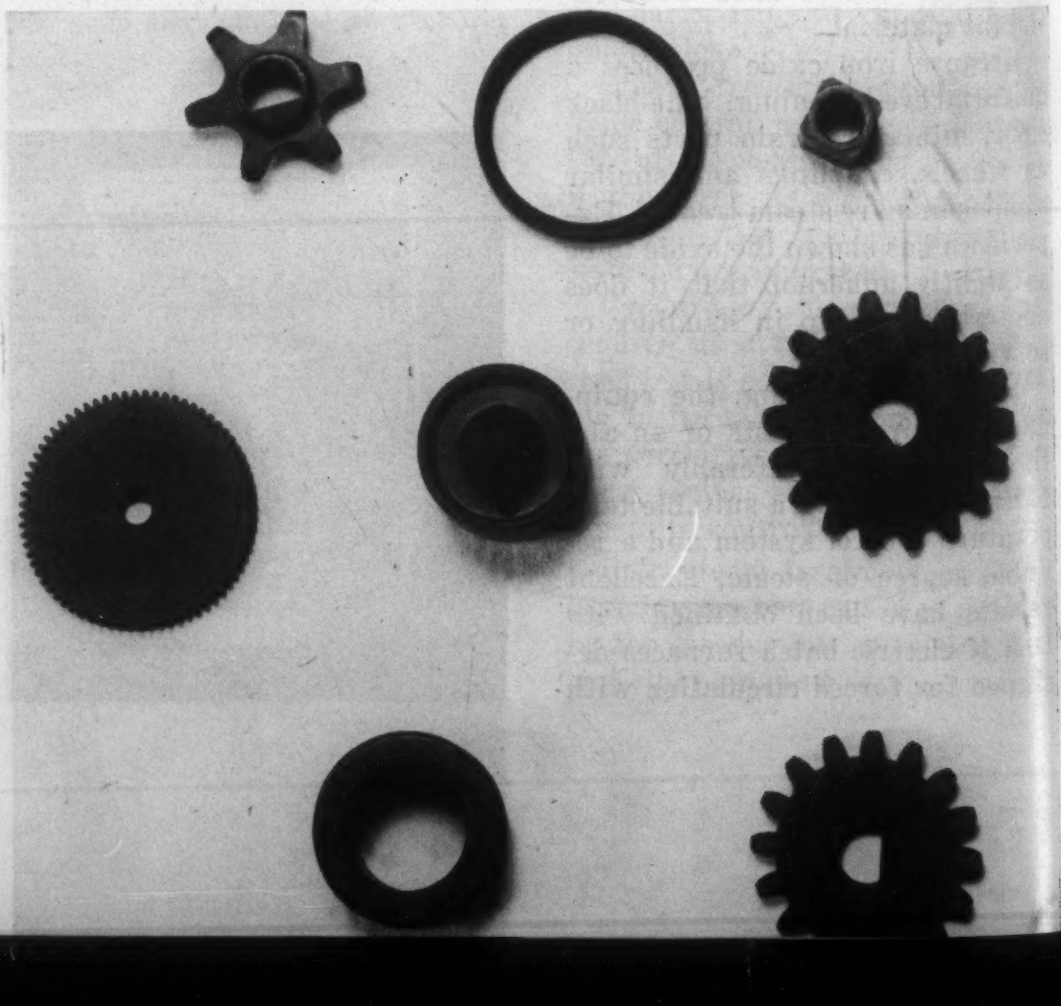
An example of the cost savings which can sometimes be made by carburizing is an aircraft instrument gear. This gear was originally hobbed from SAE 4615 steel. It is now pressed from an alloy iron powder. After sintering, the gear is case carburized to a depth of 0.035 in. in a Homocarb controlled atmosphere furnace in which the carbon potential is held automatically at 0.95% carbon during the carburizing cycle. The part is then quenched directly into oil under the same protective atmosphere. As-quenched parts require no further finishing and dimensions are held to closer tolerances than had been possible with the original method. Cost of the gear has been reduced from $1.25 to $0.30.

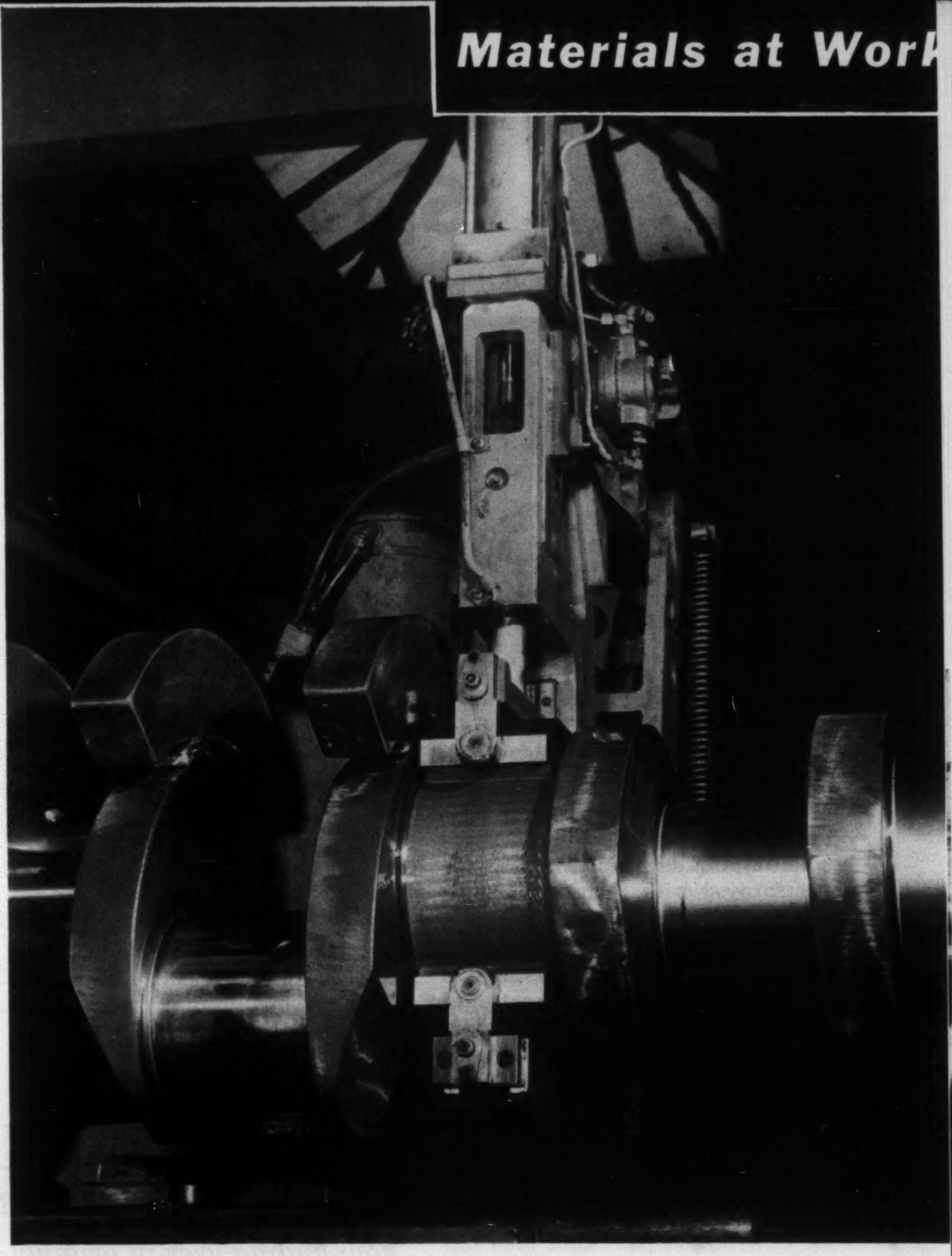


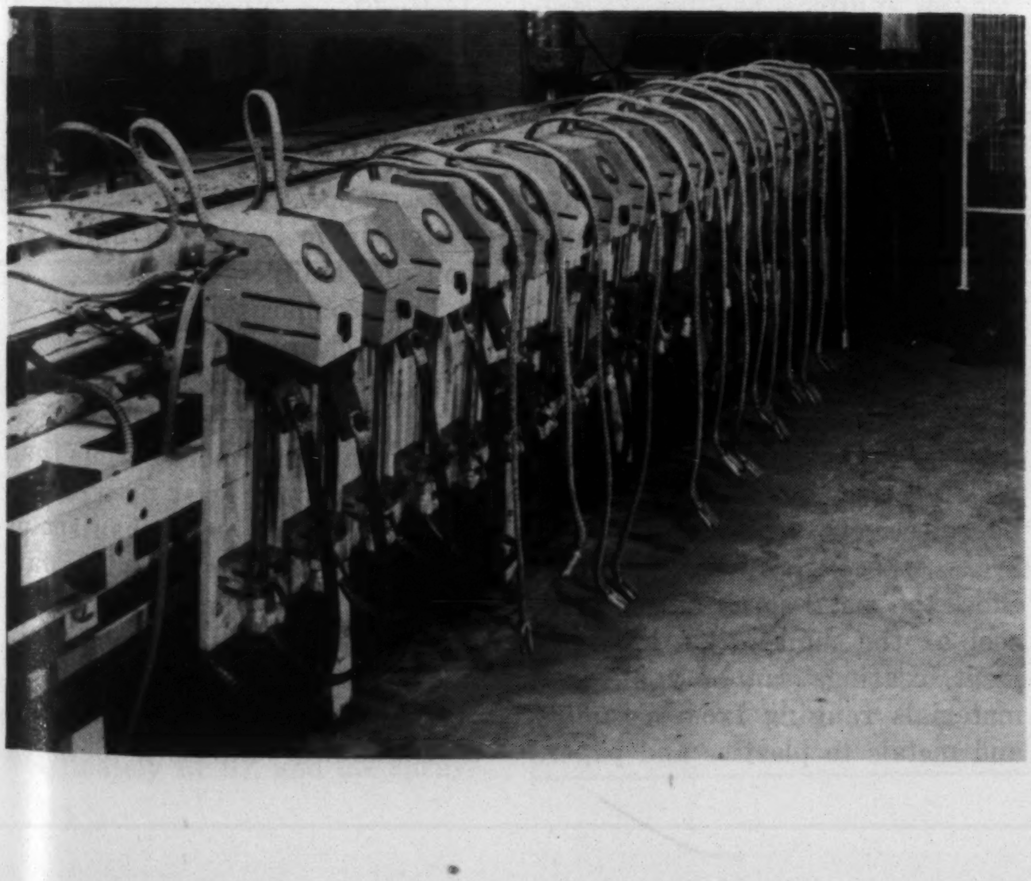
Aircraft instrument gear *formerly hobbed from SAE 4615 is now produced from iron powder. After pressing and sintering, the gear is case carburized to a depth of 0.035 in. and oil quenched. Since the part requires no additional finishing after quenching, the cost has been reduced from $1.25 to $0.30 per gear.*

(Super-Met Div. of Globe Industries, Inc.)

Gears and other parts *are steam treated to improve mechanical properties and corrosion resistance by the International Powder Metallurgy Co. Compressive strength of the narrow flange on the part in the center was increased from 1200 to 1400 psi by this treatment.*







Superfinish on chrome plated crankshaft

Chromium plated crankpins and journals are shown here being finished to a 15 rms or less finish by a superfinishing attachment mounted on a lathe with a 20 ft bed. Low friction finish is said to be unequaled for "breaking in" of bearings.

At left is the ingenious crankshaft plating tank developed and operated by Van der Horst of Olean for plating the shafts prior to superfinishing. Bank of seventeen control stations permits individual control of plating current to each journal and crankpin. As the crankshaft turns in the bath, anodes for each journal and crankpin area follow that area, maintaining the predetermined distance from the surface for proper plating. Flexibility of system allows plating to size, eliminating costly post-plating grinding operations.

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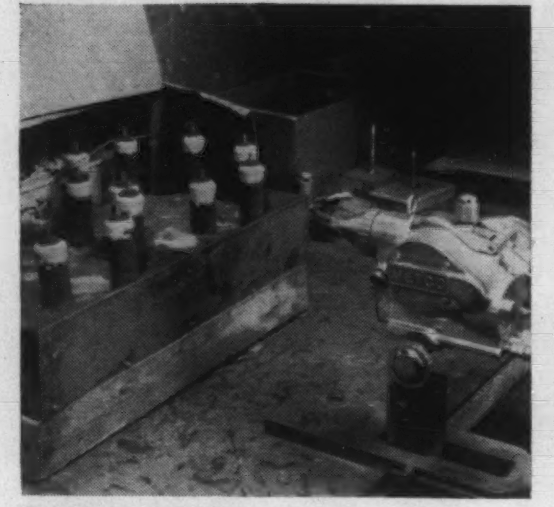


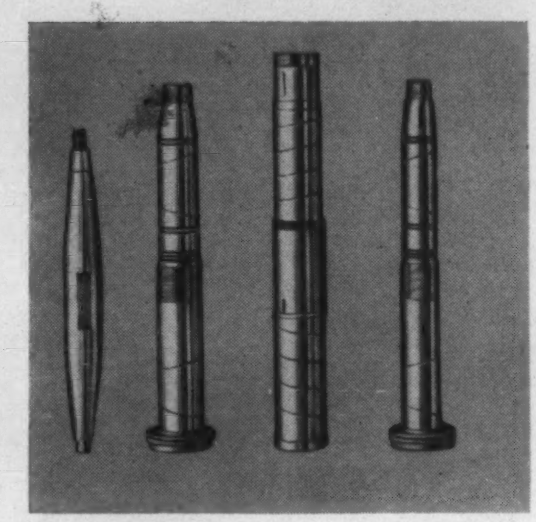
Copper

Metallized part: Resistors for temperature control units

Material coated: Ceramic

Preparation and coating: Ceramic material first sand blasted, then ends are sprayed with copper. Finish is left as-sprayed.

Advantages: Metallizing permits soldering of leads. Sand blasting and coating must be carefully controlled to avoid disturbing resistors' characteristics. Metallizing has increased production at Bendix Aviation by 400%.



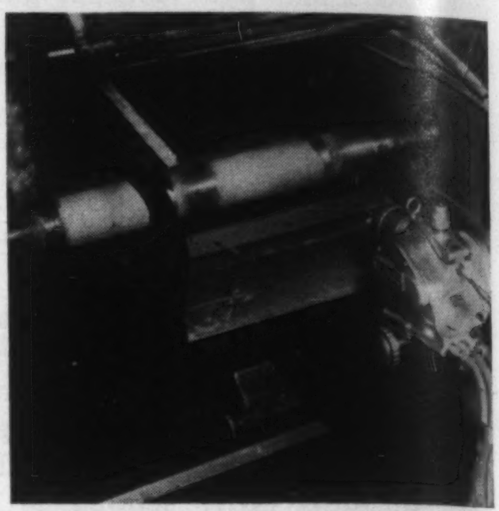
Molybdenum

Metallized part: Spindle bearings for grinding machines

Material coated: Bronze

Preparation and coating: Molybdenum sprayed directly on clean surface.

Advantages: Uncoated spindles wore and had to be replaced after a few days or a month. Metallized spindles have operated over 16 mo without failure. After 1 yr service, one spindle showed no change in diameter. Porosity of coating retains lubricants.



High Carbon Stainless Steel

Metallized part: Shaft for steam turbines

Material coated: Steel

Preparation and coating: Surface is grooved with a round-nosed tool, then burred. Stainless alloy is sprayed on surface, wet ground and polished.

Advantages: High carbon stainless provides the combination of wear resistance and rust protection necessary. Carbon rings at the end of shaft trap and condense steam, which would rust uncoated turbine shafts.

Long used as a build-up and repair tool, metallizing is now finding uses in original product manufacture.

by **D. A. Watson,** *Metallizing Engineering Co., Inc.*

■ Sprayed metal coatings provide the engineer with an economical means of imparting a wide range of desired mechanical and physical characteristics to particular areas of a product. They can materially increase flexibility of design. Such properties as hardness, thermal conductivity, electrical characteristics, corrosion resistance and solderability can be selectively applied to specific areas where they are required. Since the metal spray is relatively cool at the moment of impingement, coatings can be applied to materials ranging from ceramics and metals to plastics and paper. All common metals and alloys can be sprayed, including aluminum, zinc, copper-base alloys, nickel, molybdenum and mild, high carbon and stainless steels.

The composition of sprayed metal is chemically and physically different from that of the original wire. In general, it is harder, more brittle and more porous than its equivalent in cast or wrought form. Though the mechanism of attachment of the metallic particles to each other and to the base materials is not completely known, it is evidently a combination of several factors. There is a mechanical interlock between

TABLE 1—HARDNESS OF SPRAYED METAL

Metal	Rockwell Hardness
Aluminum	H 72
Babbitt A	H 58
Bronze	B 78
Bronze	B 18
Copper	B 32
Monel	B 39
Nickel	B 49
18-8 Stainless	B 78
High Cr stainless	C 29
Iron	B 80
Steel (0.10 C)	B 89
Steel (0.25 C)	B 90
Steel (0.80 C)	C 36
Tin	H 10
Zinc	H 46
Molybdenum	C 38

in Product Design

Bearing Surface

Bronze

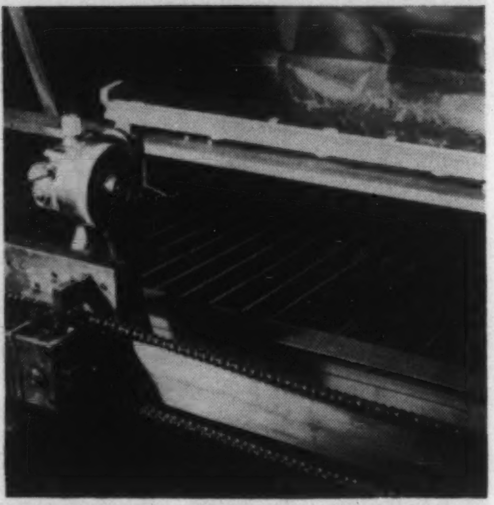
Metallized part: Compressor pistons in diesel engines and pumps.

Material coated: Steel

Preparation and coating: Surfaces are polished, then sprayed with molybdenum undercoat, which is rough-threaded. A 1/16-in. coating of Tobin type bronze is then sprayed over threaded molybdenum surface and machined.

Advantages: Good bearing surface prevents scoring of cylinder walls.

Hard Surface



Low Carbon Steel

Metallized part: Adding machine carriage rail

Material coated: Cast aluminum

Preparation and coating: Casting blasted with steel grit, then sprayed with 0.060 in. thickness of 0.25% carbon steel. Deposit then milled to 0.035 in. thickness.

Advantages: Hard steel surface on aluminum rails reduces weight of each machine by more than 5 lb. Parts have been produced at a rate of 300 to 400 rails per month for over 2 yr with only one rejection due to poor spraying.

Corrosion Protection

Zinc

Metallized part. Lock joint rings for concrete pipe

Material coated: Steel

Preparation and coating: Surface steel grit blasted, then sprayed with 0.003 in. of zinc. As-sprayed finish is satisfactory.

Advantages: Metallizing provides smoother surface than galvanizing, which leaves drippings which must be filed off, according to Lock Joint Pipe Co. Metallizing costs are estimated at 1/2 to 1 cent cheaper per basic pound than galvanizing.

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particles and, in some cases, a small amount of welding at some points between particles. There is also a degree of oxide cementation between particles. Physical properties of sprayed metal, therefore, include properties of the particles, degree of cohesion for each other, degree of porosity of the coating, and its oxide content.

Properties

Since hardness of sprayed metals depends on the factors just mentioned, hardness tests cannot be used to compare true hardness of sprayed metal with that of metal in other forms. They should be used only to compare one sprayed metal with another. For example, in Table 1 hardness of sprayed high carbon steel is given as Rc 36. Actually the hardness of particles is approximately Rc 67, and the sprayed coating will resist non-lubricated wear as well as hardened high carbon steel.

When applied to metallic materials, metallized coatings do not normally add to the strength of the base material though they do add some stiffening effect. Table 2 lists ultimate tensile strengths of various sprayed metal coatings.

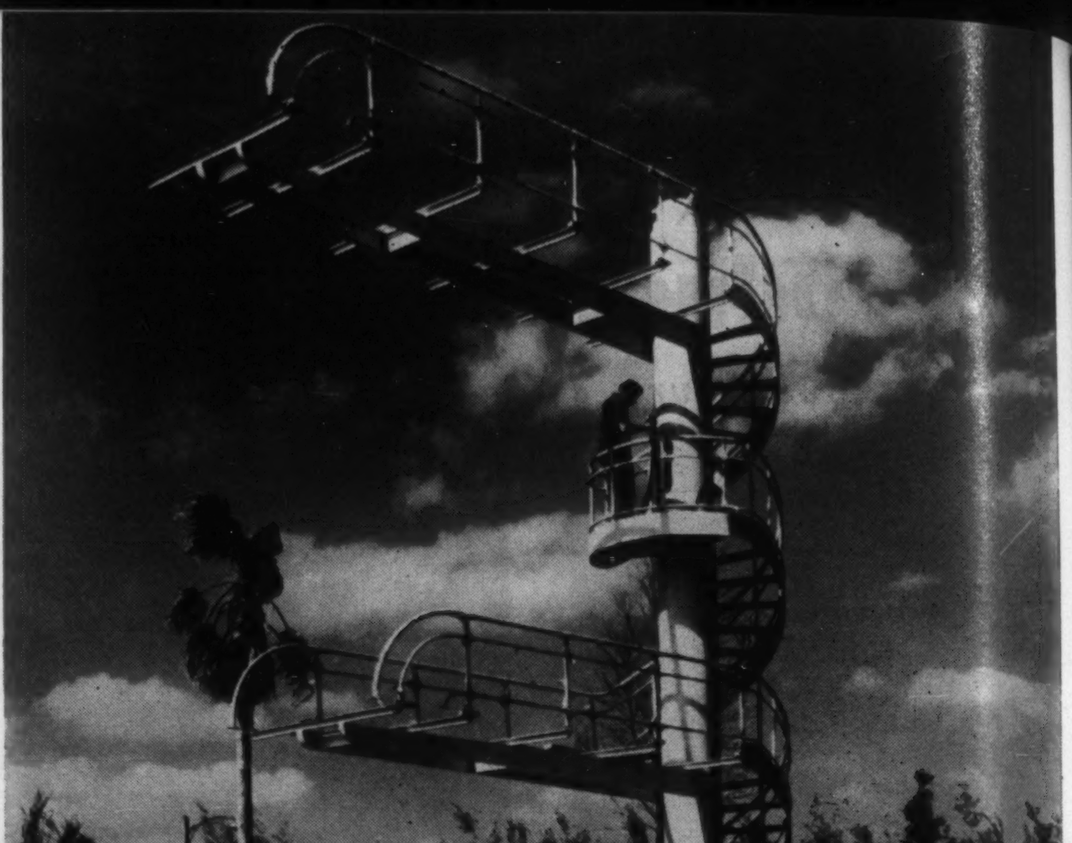
TABLE 2—TENSILE STRENGTH OF SPRAYED METALS

Metal	Ult Str, psi	Strain at Ult, % increase in length
18-8 Stainless	30,000	0.27
High Cr stainless	40,000	0.50
Iron	28,000	0.25
Steel (0.10 C)	30,000	0.30
Steel (0.25 C)	34,700	0.46
Steel (0.80 C)	27,500	0.42
Aluminum	19,500	0.23
Aluminum (Faster spraying, better machinability)	37,000	0.54
Bronze	29,000	0.46
Bronze	13,000	0.51
Zinc	13,000	1.43
Molybdenum	7500	0.30

What is Metallizing?

Metallizing is the process of spraying molten metal onto a surface to form a coating. Pure or alloyed metal in the form of wire is melted in a flame gun and atomized by compressed air into a fine spray. Though the metal is molten when it leaves the gun, the blast of air and gas cools it so that by the time it impinges on the surface it is in the form of "cool" semi-molten particles. The particles build up on the surface to form a metal coating of any desired thickness.

So cool are the particles when they reach the surface that little or no fusion results. The resultant bond between coating and base metal is primarily a mechanical one. Force with which the particles strike the surface and other deposited particles, causes deformation and interleaving of particles, increasing the strength of the bond.



Sprayed aluminum *is used to provide a corrosion resistant coating for this diving tower at Shamrock Hotel in Houston.*

Tensile tests of sprayed metal measure strength of particle attachment almost entirely. Since there is some shrinkage which sets up internal stresses during application, tensile tests measure the difference between actual strength and internal stresses.

Knowledge of tensile properties of sprayed metal is important for two major reasons: their effect on wear qualities and their effect on cracking of coatings. One of the mechanisms of wear is the tearing away of entire particles by abrasive matter, or by "welding" in more severe service. This type of wear is resisted by the degree of cohesion of particles forming the bearing surface. Tensile strength is the measure of this cohesion. By taking tensile properties and shrink of sprayed metal into consideration when selecting a coating, cracked coatings can be avoided. If a metal has a high shrink it may crack, even if it has high strength. If it has low shrink, it will not crack even if it has low strength. To obtain optimum crack-free coatings, metals with low shrinkage and high tensile strength should be selected where possible.

Density of sprayed metals usually ranges from 5 to 10% less than that of the original wire, due to porosity. Porosity can be advantageous or disadvantageous, depending on the application. It is particularly useful in bearing applications where porosity holds lubricants thereby increasing service life of the bearing. On the other hand, where corrosion resistance is required it can be disadvantageous. Sprayed metals such as stainless steel, nickel or bronze are not good for cathodic corrosion protection due to their porosity which can result in under-film corrosion. Protection is usually obtained by using anodic metals such as zinc or aluminum which behave sacrificially during galvanic corrosion. When these metals are used, porosity is of little importance.

Preparing metallic surfaces

There are three basic methods of preparing a metallic surface for metallizing: 1) heating; 2) applying an intermediate pre-coating surface; and 3) roughening the base. Heating alone is seldom used since the high temperatures required incur problems of oxidation and warpage. To provide an intermediate pre-coating surface, a molybdenum alloy can be sprayed thinly over most smooth, clean surfaces, thus providing a rough base for subsequent metallizing.

Of the three types of surface preparation, roughening is probably the most widely used. Roughening methods include grooving, grit blasting and rough threading. Grooving should be done with a round nosed tool, followed by burring to obtain 16 locks per in. This serves to strengthen both the coating and the bond. Sprayed metal has a laminated structure with greater strength parallel to laminations than perpendicular.

Folding laminations over relatively large grooves or bumps materially improves the strength of the coating and prohibits splitting. Also shrinkage, which is particularly important in heavy coatings, is restrained by grooving. By restraining shrinkage, grooving limits the shear stress on the bond, resulting in stronger bonds. Other roughening methods serve the same purpose in varying degrees.

Grit blasting is primarily used to prepare surfaces for thin corrosion-resistant coatings of zinc and aluminum. Necessary equipment is large and relatively expensive and is not generally warranted in small shops. While relatively high bond strengths can be obtained by grit blasting under ideal conditions, it is harder to control than other methods of surface preparation. Cleanliness is essential, and there are many variables which must be closely controlled.

Rough threading consists merely of cutting the base metal so as to produce a torn or broken V-thread. It is not very reliable due to difficulty in producing a properly torn thread. Rough threading cannot be used with some base metals such as nickel steels, brasses and bronzes since they will not tear properly. The sharp V may be the starting point for progressive cracking concealed under the coating.

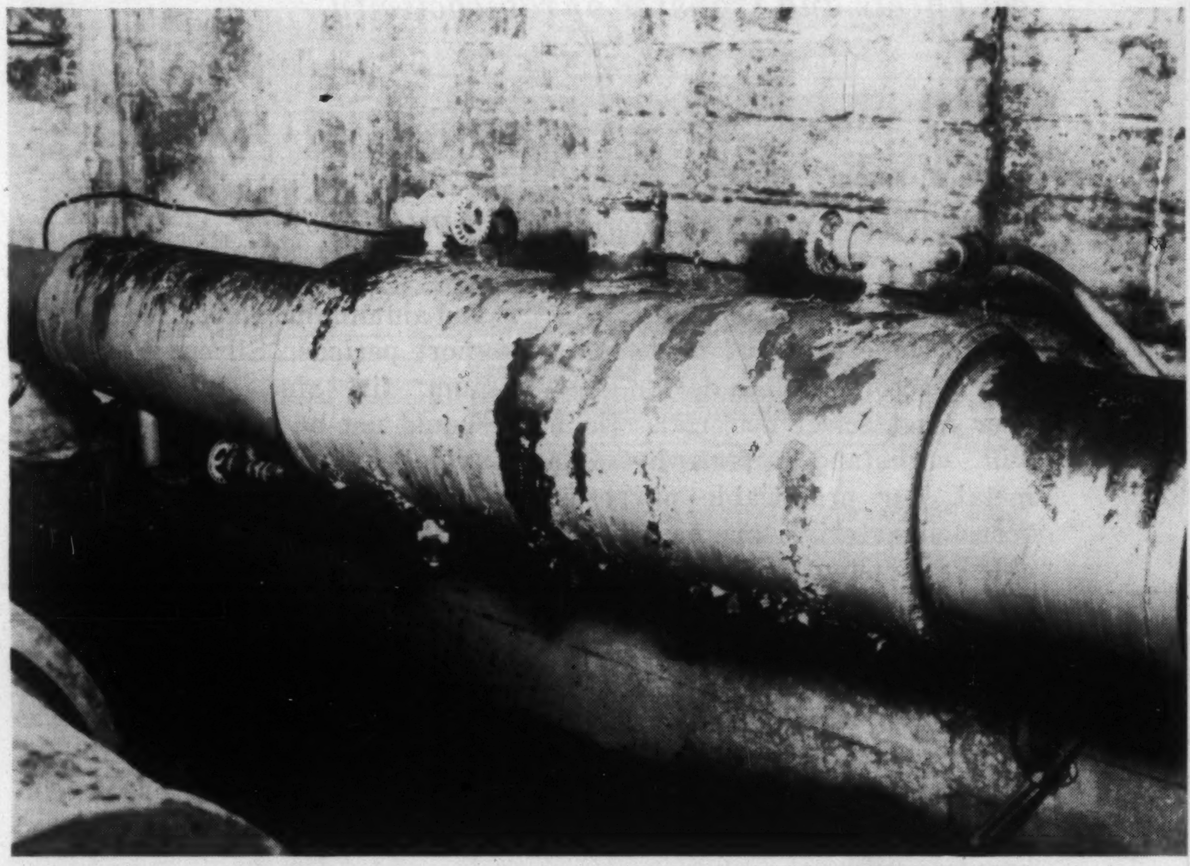
Preparing nonmetallic surfaces

Metallizing materials will bond sufficiently well to slightly porous materials such as plaster, carbon and unglazed ceramics or to soft materials such as wood, cloth, paper or hard wax, to eliminate the need for surface preparation other than cleaning. It is very important to have the surfaces clean and dry. In spraying glass and glazed ceramic materials, surfaces are frequently pre-heated to gain optimum bond. Generally, glass is heated to temperatures of about 500 to 900 F depending on the type of glass. The temperatures which are used for preparing glazed ceramics must be determined for each type.

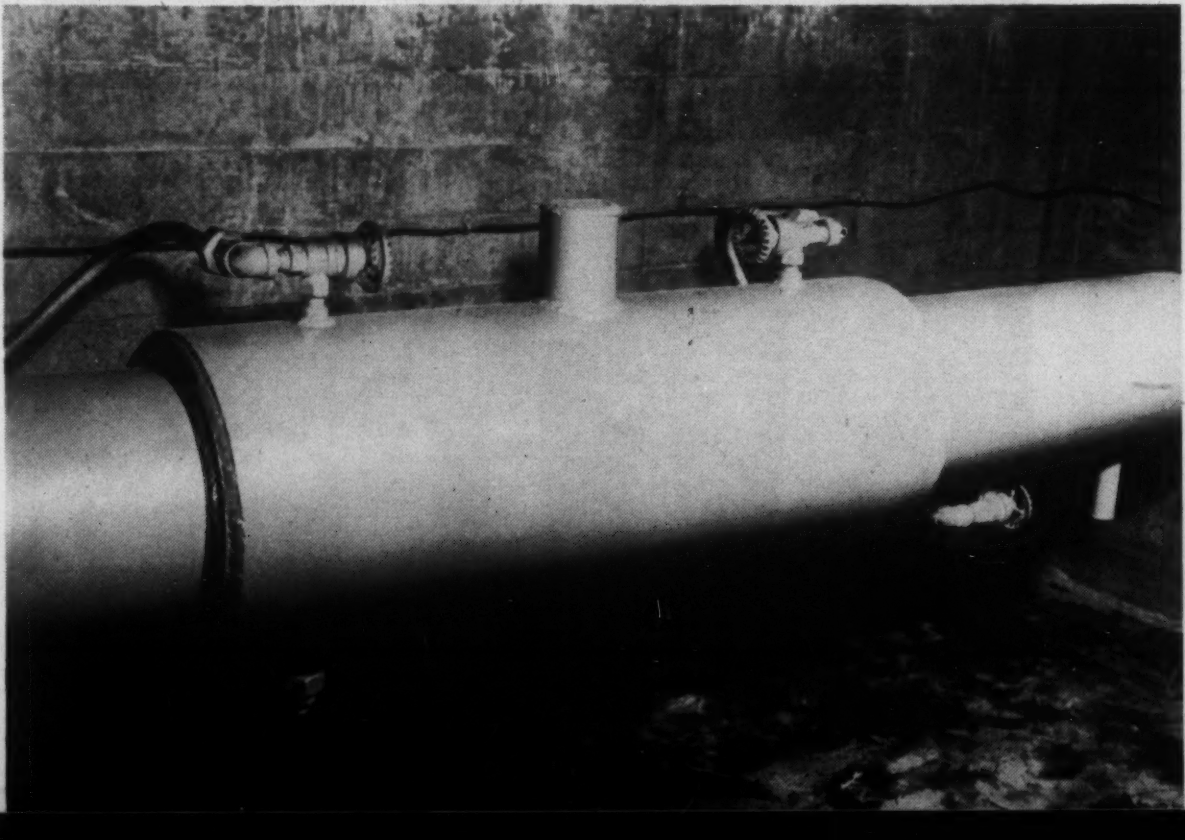
Plaster and wood can only be sprayed directly with lower melting point metals such as aluminum, zinc, tin and lead. Usually a zinc, tin or lead bonding coat 0.003 to 0.005 in. thick is applied, then the higher melting point metal over this bonding coat. Most plastics require some roughening by light grit blasting to gain optimum adhesion. As in the case of wood and plaster, it is usually necessary to spray an undercoat of low melting point metal where higher melting point metals are to be applied.

TABLE 3—COMPARATIVE SHRINK OF SPRAYED METALS

Metal	Shrink, in. per in.
18-8 Stainless	0.012
High Cr stainless	0.0018
Iron	0.009
Steel (0.10 C)	0.008
Steel (0.25 C)	0.006
Steel (0.80 C)	0.0014
Aluminum	0.0068
Bronze	0.0055
Bronze	0.010
Zinc	0.010
Molybdenum	0.003



***Combinations** of metallized and organic coatings is exemplified in this before-and-after shot of an underground conduit. Top photo shows painted conduit after 6 mo to 1 yr service. Bottom, conduit metallized with zinc and coated with aluminum-vinyl formulation.*



Structural Materials for Heat Transfer in Nuclear Reactors

1. Selecting Materials for Liquid Sodium Systems

The advantages of sodium as a heat transfer agent make it particularly suitable for nuclear energy reactors. The problems differ in many respects from those with water. They include corrosion resistance, mass transfer, mechanical effects and transfer of radioactivity.

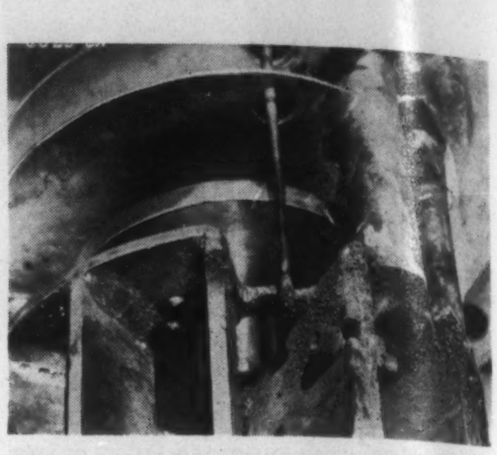
by R. F. Koenig and E. G. Brush,

Knolls Atomic Power Laboratory, General Electric Co.

■ Liquid sodium is used as a coolant in some types of nuclear energy reactors and the design engineer must select materials which will withstand attack by this metal. For practicable purposes, ferrous materials are most suitable and austenitic stainless steels of the 18:8 type have been most widely used. Although early experience indicated that the columbium-stabilized grade was necessary it has been found that type 304 is suitable for service at least to 1000 F. Metals such as copper and aluminum can be used for only short periods. Silver, gold, platinum, tin, zinc and magnesium should not be used in sodium for extended time periods.

Materials used

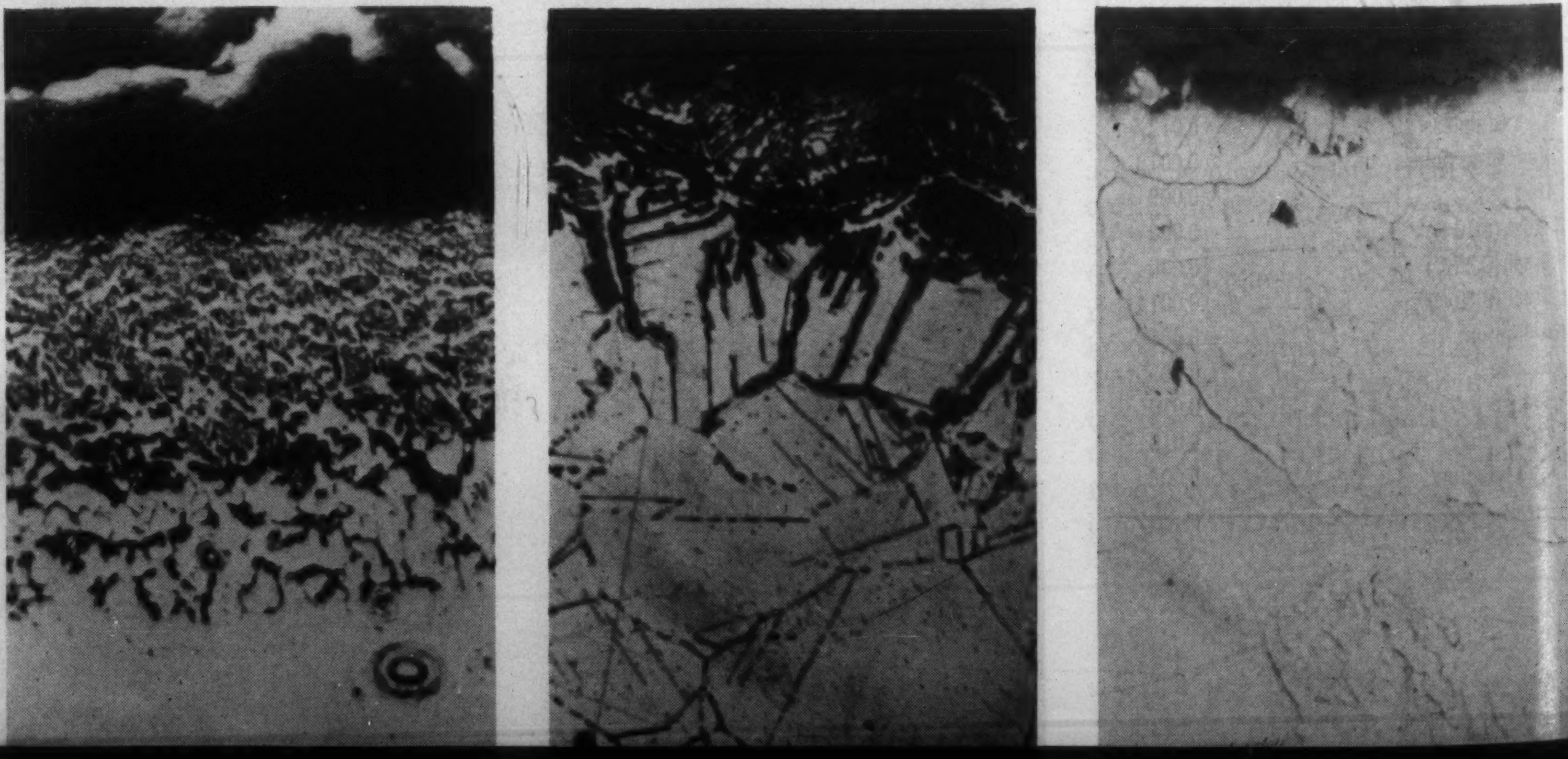
Ferrous metals—Most sodium systems which has been built and operated for any length of time were made principally from type 347 stainless steel because it was believed that columbium stabilization was necessary to prevent intergranular attack. When the need for going to less strategic and less expensive steels was recognized, an intensive development program for alternate materials was undertaken at the Knolls Laboratory. The principal material of this category is type 304 stainless steel which has proved to be in every way as resistant to corrosion in sodium as type 347 up to 1000 F. Experience above this temperature is very limited and it is not possible to draw any conclusions except that no difference between types 304 and 347 has appeared at the higher temperatures. For long-time service and temperatures below 1000 F, type 304 stainless steel is recommended.



Mass transfer of copper in sodium. Copper crystal deposited in baffle plates which were immersed in sodium running 20 F colder than the sodium surrounding the copper specimen rotating within the baffles.

In a further attempt to reduce the alloy content, considerable work has been done with the fer-

Corrosion of metals by sodium contaminated with 0.5% oxygen in 1 month exposure at 1300 F. Severe intergranular attack of A-286 (left) and type 304 stainless (center). Corrosion product on molybdenum (right) sloughs off, being formed at a rate (4 ipy) sufficiently high to prevent intergranular attack. (Magnification 500x.)



ritic steels; carbon, low chromium, and higher chromium (through 12% Cr) alloy steels.

For short periods of operation and possibly for long periods, ordinary carbon and low alloy 1% or 2¼% chromium steels are satisfactory under proper conditions. Use of these steels involves many problems not present with austenitic stainless steels. They must be more carefully protected from rusting during fabrication. Corrosion decreases with reduction in chromium content.

The low alloy steels are subject to decarburization in sodium contaminated with small amounts of oxygen. The magnitude of this effect depends upon the level, the temperature, and the chromium content of the alloy. Decarburization in the low alloy steels is promoted by the presence of austenitic stainless steel because of the strong "gettering" action of chromium or of the stabilizing elements, columbium and tantalum. This effect is minimized by alloying with chromium to form a stable carbide in the ferritic steel. Experience in large scale systems indicates that 1 to 2% chromium is probably sufficient, but ferritic to austenitic steel surface ratios and design oxygen conditions should be tested before system materials are specified.

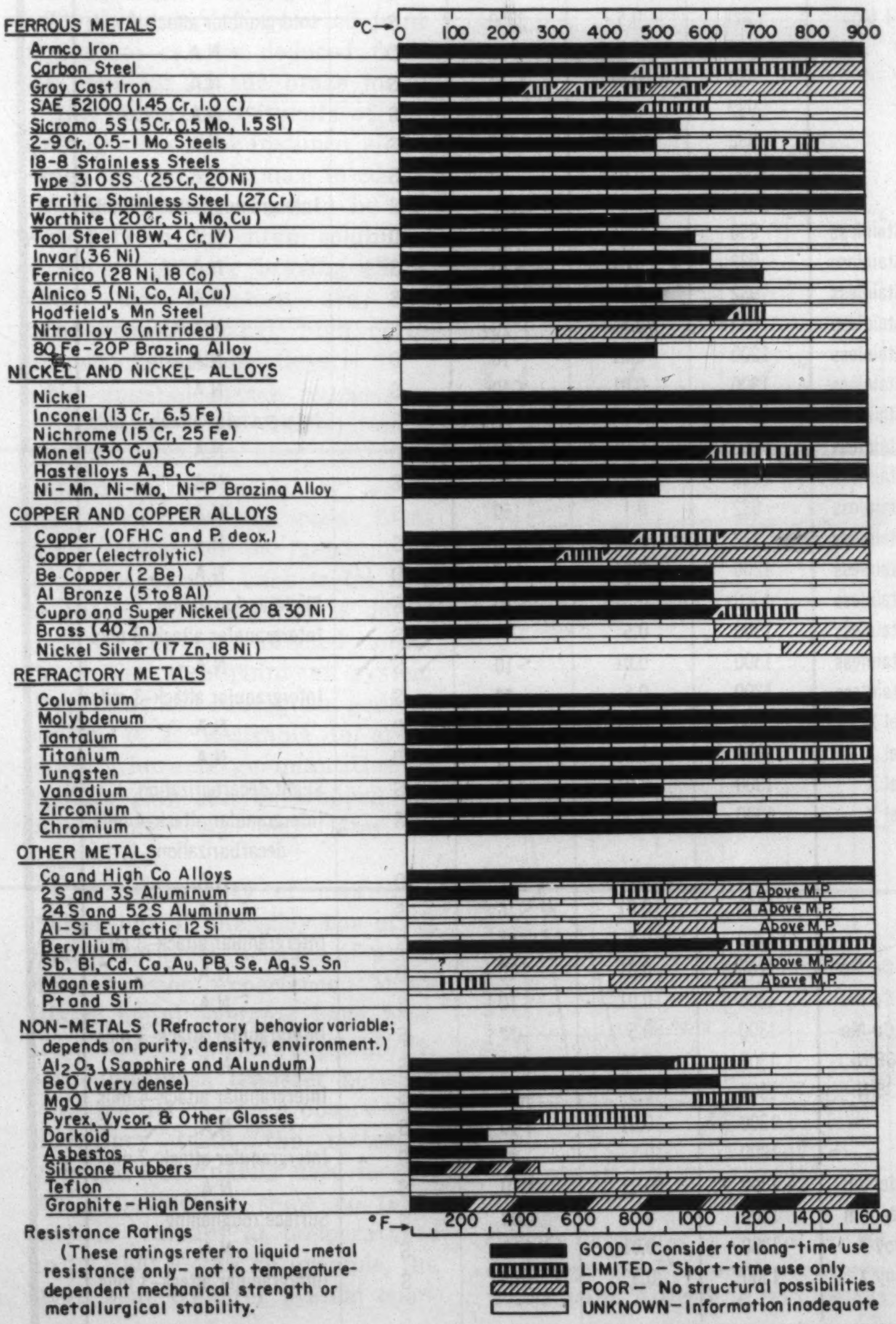
Greater tendencies for mass transfer have been observed with low alloy steels. It may be possible that cold traps can be used to collect both sodium oxide and iron crystals. Although several large carbon steel heat transfer systems are planned, there is no experience which can be cited at this time. Actual corrosion rates observed with carbon steel (10 mg/dm^2-mo) have been negligible in most syssystems design. Furthermore, no indication of preferential attack has been observed with pure sodium (less than 0.005% oxygen).

Superalloys and refractory metals—A number of the superalloys and refractory metals have been exposed to static screening and system type testing. In general, they are as resistant to corrosion in sodium as any of the austenitic stainless steels. The standard cobalt-base alloys, S-590 and S-816; the nickel base alloys, Inconel and Inconel X; and pure nickel, all should be suitable for service in sodium up to 1000 F.

Ceramics and cermets—Tungsten carbide, titanium carbide, and chromium carbide, bound with either nickel or cobalt, have excellent resistance to attack in sodium. Much work has been done with these materials for bearings and journals. Experience with these cermets has been satisfactory. No trouble would be expected with these materials under 1000 F.

With the true ceramics the problem is somewhat different. Pure alumina, magnesia, titania, zirconia, etc. are uneffected by exposure to sodium. The difficulties which arise are primarily mechanical in nature. Many of these ceramic bodies are porous and absorb sodium when they are exposed to it. Subsequent thermal cycling produces cracking. Many of the binders, especially silicates, react with sodium. The dense-

Resistance of materials *to liquid sodium and sodium potassium alloys.*
(From Liquid Metals Handbook)



CORROSION OF STRUCTURAL MATERIALS IN SODIUM

Material	Temp, F	O_2, Wt %	Loss of Metal, mg/dm²-mo	Static or Dynamic	Results of Metallographic Examination
Iron	950	0.01	20	D	N.A.*
Carbon steel	932	0.01	10	S	Decarburized 10 mils
1¼ Cr–½ Mo	932	0.01	10	S	N.A.
2¼ Cr–1 Mo	950	0.01	<10	D	N.A.
5 Cr–½ Mo	950	0.01	<10	D	N.A.
5 Cr–½ Mo	932	0.01	<10	S	N.A.
5 Cr–½ Mo	932	0.1	180	S	N.A.
5 Cr–½ Mo	932	0.5	580	S	N.A.
7 Cr–½ Mo	932	0.01	<10	S	N.A.
7 Cr–½ Mo	932	0.1	200	S	N.A.
7 Cr–½ Mo	932	0.5	600	S	N.A.
9 Cr–1 Mo	950	0.01	<10	D	N.A.
9 Cr–1 Mo	932	0.01	<10	S	N.A.
9 Cr–1 Mo	932	0.1	200	S	N.A.
9 Cr–1 Mo	932	0.5	540	S	N.A.
9 Cr–1 Mo	1300	0.01	40	S	Slight surface roughening
9 Cr–1 Mo	1300	0.5	3700	S	Intergranular attack–6 mils
12 Cr	950	0.01	<10	D	N.A.
12 Cr	932	0.01	<10	S	N.A.
12 Cr	932	0.1	70	S	N.A.
12 Cr	932	0.5	510	S	N.A.
12 Cr	1300	0.01	40	S	N.A.
12 Cr	1300	0.5	2600	S	Intergranular attack–5 mils
304 Stainless	950	0.01	<10	D	N.A.
304 Stainless	932	0.01	<10	S	N.A.
304 Stainless	932	0.1	–**	S	N.A.
304 Stainless	932	0.5	20	S	N.A.
304 Stainless	1200	0.01	<10	D	N.A.
304 Stainless	1300	0.01	<10	S	N.A.
304 Stainless	1300	0.5	–**	S	Intergranular attack–3 mils
347 Stainless	950	0.01	<10	D	N.A.
347 Stainless	932	0.01	<10	S	N.A.
347 Stainless	932	0.1	50	S	N.A.
347 Stainless	932	0.5	50	S	N.A.
347 Stainless	1200	0.01	<10	D	N.A.
347 Stainless	1300	0.01	<10	S	Slight carburization
347 Stainless	1300	0.5	–**	S	Intergranular attack–3 mils
310 Stainless	1300	0.01	<10	S	N.A.
310 Stainless	1300	0.5	–**	S	Intergranular attack–3 mils
Inconel X	950	0.01	<10	D	N.A.
Inconel X	1200	0.01	<10	D	N.A.
Inconel X	1300	0.01	10	S	Slight decarburization
Inconel X	1300	0.5	–**	S	Intergranular attack–4 mils +decarburization
A-286	1200	0.01	<10	D	N.A.
A-286	1300	0.01	<10	S	N.A.
A-286	1300	0.5	–**	S	Intergranular attack–3 mils
17–14 Cu Mo	1200	0.01	<10	D	N.A.
17–14 Cu Mo	1300	0.01	<10	S	N.A.
17–14 Cu Mo	1300	0.5	–**	S	Intergranular attack–3 mils
18 Cr–35 Ni	1300	0.01	<10	S	N.A.
18 Cr–35 Ni	1300	0.5	–**	S	Intergranular attack–4 mils
M 600	1300	0.01	<10	S	N.A.
M 600	1300	0.5	–**	S	Intergranular attack–3 mils
Molybdenum	1300	0.01	<10	S	N.A.
Molybdenum	1300	0.5	800	S	Surface roughening
Hastelloy X	1300	0.01	<10	S	N.A.
Hastelloy X	1300	0.5	–**	S	Intergranular attack–3 mils

**N.A. = No intergranular attack, surface roughening, pitting, carburization, decarburization, or sub-surface void formation.*

***Large weight gains which have no significance as an indication of corrosion.*

fired, pure oxides perform most satisfactorily.

Impurities in sodium

The purity of the sodium has a pronounced effect on the corrosion rates and must be considered in determining the suitability of a material for service under specific conditions.

Oxygen and carbon have been investigated most extensively. With sodium containing calcium, nitrogen is a problem because it reacts to form calcium nitride, an insoluble precipitate. Some consideration has been given to hydrogen, probably present as dissolved sodium hydroxide, because of its effect on nuclear reactivity of atomic power plants. No detrimental effects from the standpoint of the structural materials have been observed in the absence of irradiation with either nitrogen or hydrogen at temperatures below 1000 F.

Effect of oxygen—Sodium oxide is an aggressive corrosion agent in sodium. It oxidizes all metallic surfaces, and the degree of damage depends upon its concentration and the temperature. Stainless steel is not severely attacked by sodium oxide in less than saturation quantities up to 1000 F. However, if the oxide contamination exceeds saturation solubility intergranular attack can occur at temperatures as low as 700 F, producing an embrittled surface layer which cracks upon deformation. At temperatures above 1000 F, if the sodium oxide content exceeds a few hundredths percent, attack is prohibitively severe.

Ferritic stainless steels are more susceptible to oxidation than austenitic stainless steels. Alloy steels, containing less than 1 to 2% chromium, tend to decarburize, even at sodium oxide concentrations that are sufficiently low to produce insignificant general oxide attack.

Oxygen contamination has another detrimental effect on materials such as zirconium and hafnium which are active "getters". Just as in gaseous atmospheres at high temperatures zirconium dissolves its oxide, so it dissolves its oxide formed in oxygen-contaminated sodium. This phenomenon readily occurs at temperatures around 900 F in sodium containing only 0.005% oxygen and results in an embrittled surface layer.

It is possible to operate large systems and maintain oxygen concentrations below 0.005%. With most structural materials this concentration of oxygen is of no consequence. Methods of removing sodium oxide are discussed in the Liquid Metals Handbook.

Effect of carbon—Carbon content is important. Lubricating oil, lamp black, graphite, and other forms of carbon added to sodium will produce grain boundry carburization in stainless steels. Rate of absorption increases with time and follows standard diffusivity laws with respect to temperature. No increase in hardness of the surface layer is detectable in short periods of time at temperatures below 1000 F. However, some volume diffusion must occur and probably brittle surface layers will be formed over long periods. These will tend to restrict plastic deformation of the material.

Effect of cover gases—Sodium has been blanketed with everything from air trapped in a surge tank to the purest of helium. Most experience has been with helium or argon, although some work has been done with nitrogen as a cover gas. No difficulty of any kind has been experienced with pure helium or argon, but both gases are rare and expensive. Advantages of nitrogen are availability and low price, however, ferrous materials will be nitrided in nitrogen covered sodium at temperatures as low as 900 F. For this reason, the use of nitrogen must be evaluated under specific conditions of intended use.

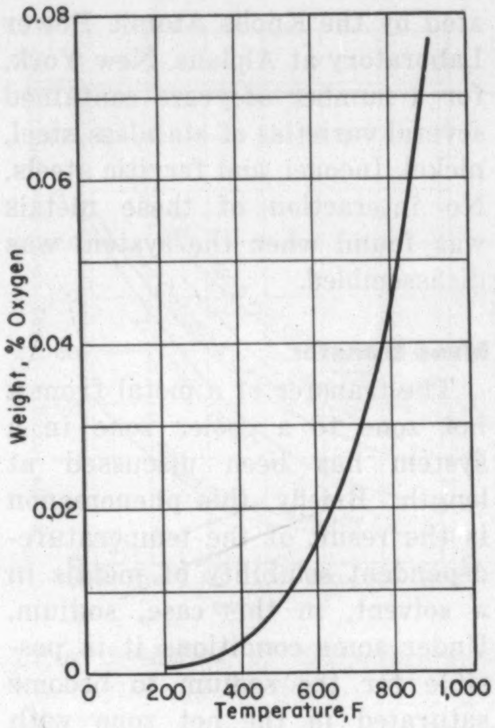
The most significant impurities in cover gases are oxygen, water vapor, and hydrocarbons. Effects of these impurities in sodium were discussed previously. Oxygen or water vapor can be tolerated in the cover gas if the rate of purification is equal to or greater than the rate of oxygen addition. However, the carburizing of stainless steel is a cumulative process and the total quantity of hydrocarbons that can be added to a system during its lifetime must be restricted. Permissible addition depends on exposed area and allowable depth of carburization. In one application, 0.0002 lb/sq ft of exposed steel area has been set as a limit for carbon addition of any kind to the system. It is more important to eliminate traces of hydrocarbons from the cover gas than to eliminate oxygen, which, unlike carbon, can be easily removed from the system.

Effect of sodium on joints

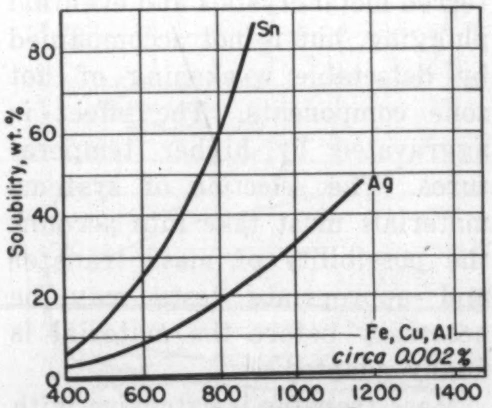
The behavior of a brazed joint in sodium can be deduced from the behavior of the braze metal or the major constituents of the brazing alloy. For instance, silver solder has no resistance to corrosion in sodium as would be expected from the high solubility of silver. Among brazing alloys which are resistant are: 60 manganese-40 nickel, high chromium-nickel-silicon alloys.

No unusual attack by sodium on welds of either austenitic or ferritic steels has been observed. Commercial stainless or other iron alloy welding rods form joints which are as resistant to corrosion as the base metal and no special susceptibility is developed in the heat-affected zones. From the standpoint of system cleanliness and subsequent sodium purity, it is desirable to avoid joints where large quantities of welding slag can be trapped because this slag may later be leached out.

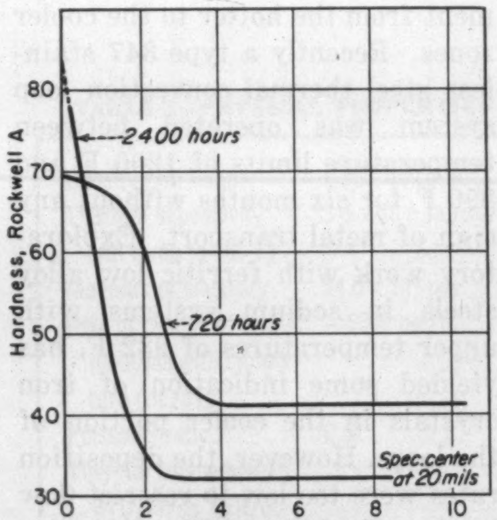
The desirability of making a system out of one alloy has often been questioned, because of aqueous corrosion experience. Many mixed metal systems have been built and operated successfully. Although mass transfer between some metals has been observed in laboratory tests, the materials which are ordinarily used in system construction show no tendency to transfer at temperatures up to 1000 F. As an example, the large heat transfer system oper-



Solubility of sodium oxide in sodium as a function of temperature.



Solubility of metals in sodium.



Oxygen absorption in crystal bar zirconium at 932 F in sodium contaminated with 0.01 to 0.1% oxygen.

ated by the Knolls Atomic Power Laboratory at Alplaus, New York, for a number of years contained several varieties of stainless steel, nickel, Inconel, and ferritic steels. No interaction of these metals was found when the system was disassembled.

Mass transfer

The transfer of a metal from a hot zone to a cooler zone in a system has been discussed at length. Briefly, this phenomenon is the result of the temperature-dependent solubility of metals in a solvent, in this case, sodium. Under some conditions it is possible for the sodium to become saturated in the hot zone with soluble elements. When the sodium is cooled, as in passing through a steam generator, it tends to precipitate the excess solute at the lower temperature. This leads to a build-up of transferred metal crystals and eventual plugging, but is not accompanied by detectable weakening of hot zone components. The effect is aggravated by higher temperatures. The selection of systems materials must take into account the possibility of mass transfer and appropriate tests may be necessary before the material is finally adopted.

Mass transfer is extensive with some coolants but rare with sodium at temperatures below 1000 F. Numerous stainless steel systems have been operated in this temperature range without the slightest indication of metal movement from the hotter to the cooler zones. Recently a type 347 stainless steel thermal convection loop system was operated between temperature limits of 1200 F and 890 F for six months without any sign of metal transport. Exploratory work with ferritic low alloy steels in sodium systems with upper temperatures of 932 F, has yielded some indication of iron crystals in the cooler portion of the loops. However, the deposition rates were too low to restrict flow in the normal operating life of a ferritic reactor system. Copper, on the other hand, transfers extensively in sodium above 600 F, and has limited use in sodium-cooled heat transfer systems.

Some materials transfer preferentially in the presence of dissimilar metals. Such behavior may restrict the use of aluminum gaskets in ferrous systems because of the rapid formation of iron-aluminum compounds at temperatures above 600 F.

Transfer of radioactivity

Designing liquid metal systems to remove heat from nuclear reactors presents a special problem because of the transfer of radioactivity. Although most structural materials are sparingly soluble in sodium, those in the reactor core and those in solution in the coolant which are activated by neutron capture can diffuse throughout the system and produce relatively high levels of radioactivity in what would ordinarily be nonradioactive areas. Long-lived activity transfer can be minimized by using tantalum-free and cobalt-free materials in the reactor core and in the primary coolant system. Chromium-51, manganese-56 and iron-59 constitute the principal radioisotopes which produce short-lived, high-level activity. Regardless of the steps taken to minimize this effect, sufficient radioactivity, in addition to that of the sodium, may migrate around reactor coolant systems to restrict accessibility.

Mechanical effects

Two difficulties of entirely different natures occur frequently in liquid metal systems. The first of these is galling of threaded and sliding parts. Galling can be classified as initial movement followed by increasing resistance to movement and eventual stoppage or surface damage; that is, after a bolt joint is released but before the bolt is completely removed, it galls and freezes solid.

Galling can be prevented by good design and by methods such as surface treatment. Design possibilities are: 1) very loose, running fits, 2) tapered threads, 3) exceptionally smooth surfaces. Of potential surface treatments, nitriding has probably been used most widely and successfully. Nitrided cases of one to three mils have been effective in preventing galling. A second method is chromium plating, which although apparently effective, has not been used extensively. Chromium is not attacked by sodium, but a perfectly bonded plate is required to prevent flaking or spalling during operation. Most conventional lubricants like oils, molybdenum disulfide, and graphite react with sodium and are not maintained in the places where they are needed to prevent galling.

The second effect is self welding, which occurs when two materials are placed in intimate contact in sodium under pressure. This is a diffusion welding process which might occur, for example, with a valve plug in a valve seat or a similar application where intimate contact is maintained for long periods of time. The scavenging action of sodium catalyzes diffusion welding.

Diffusion bonding or self welding is primarily a time and temperature-dependent phenomenon, and as such is not readily prevented by design measures which reduce contact pressures. Interposing a different material is the best known way of eliminating this undesirable condition. Less work has been done on preventing self-diffusion than on preventing galling, and little experience is available. However, surface treatments like nitriding appear to be effective in minimizing self welding. Since this is a diffusion-type process, the tendency to self weld increases rapidly with temperature.

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Structural Materials for Heat Transfer in Nuclear Reactors

2. A Zirconium Alloy for Water Systems

Use of Zircaloy-2 has grown along with the development of water-cooled reactors. This article summarizes the information now available on the physical and mechanical properties and corrosion behavior of this alloy.

by D. E. Thomas and F. Forscher,
Atomic Power Div., Westinghouse Electric Corp.

■ The low neutron absorption of zirconium makes it an attractive material for nuclear reactors. Commercially pure zirconium, however, has two important drawbacks: low strength and highly variable corrosion behavior.

To overcome these disadvantages, the Westinghouse Atomic Power Division developed in 1952 a low alloy of zirconium known as Zircaloy-2. With a nominal composition of 1.5 tin, 0.12 iron, 0.05 nickel and 0.10% chromium, it has better design strength than zirconium and consistently good corrosion resistance in high temperature water, yet it retains enough ductility to be fabricated and shows little change in neutron absorption.

Mechanical properties

Physical properties of Zircaloy-2 are listed in Table 1, and mechanical properties are given in Fig 1 and 2 and in Table 2.

Strength—Tensile strength in the longitudinal direction decreases with increasing temperature and after annealing, as shown in Fig 1. At all temperatures, transverse tensile properties of hot rolled material differ little

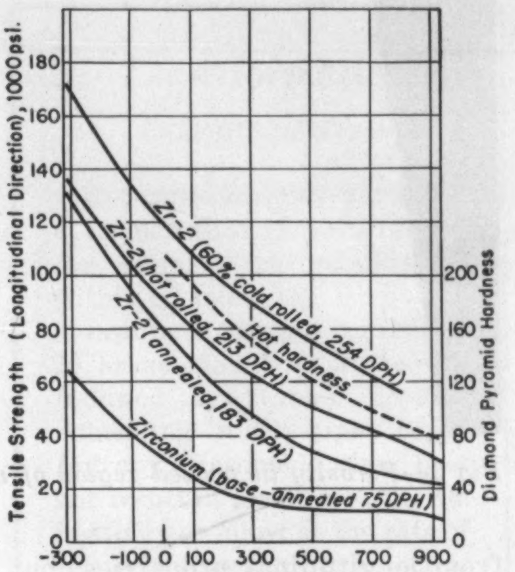


Fig 1—Effect of temperature on strength and hardness.

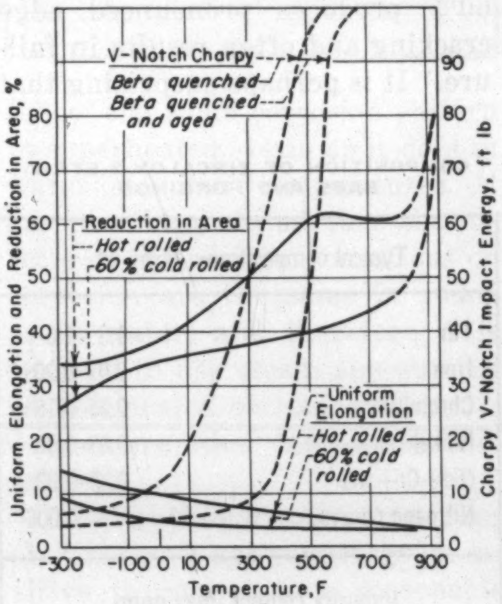


Fig 2—Effect of temperature on ductility and impact strength.

TABLE 2—MECHANICAL PROPERTIES[a]

Property	At room temperature				At 500 F			
	Longitudinal		Transverse		Longitudinal		Transverse	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
AS-RECEIVED[b]								
Yield strength (0.2% offset), 1000 psi	49	±6	70	±5	24	±3	34	±7
Tensile strength, 1000 psi	76	±3	78	±5	42	±2	42	±5
Reduction in area, %	28	±5	37	±6	42	±8	52	±4
BASE-ANNEALED[c]								
Yield strength (0.2% offset), 1000 psi	45	±2	68	±2	—	—	—	—
Tensile strength, 1000 psi	75	±2	74	±2	—	—	—	—
Reduction in area, %	28	±3	40	±3	—	—	—	—

[a] *Average based on one specimen per condition per ingot from 10 ingots.*
[b] *History: (1) 80% reduced by forging at 1800 F, (2) 97% reduced by rolling at 1550 F, (3) 5% cold reduced, and (4) annealed 10 min at 1550 F.*
[c] *Heated 20 hr at 1380 F in vacuum, then furnace cooled.*

TABLE 1—PHYSICAL PROPERTIES

Density (rm temp)	0.237 lb/cu in.
Thermal expansivity (rm temp to 660 F)	3.6×10^{-6} in./in./F
Modulus of elasticity	14.0×10^{6} psi
Rate of change of elastic modulus with temperature (dE/dT)	—5500 psi/F
Poisson's ratio	0.31
Thermal conductivity: BTU/hr/sq ft/ft/F	
at 77 F	8.41
at 212 F	8.12
at 752 F	8.19

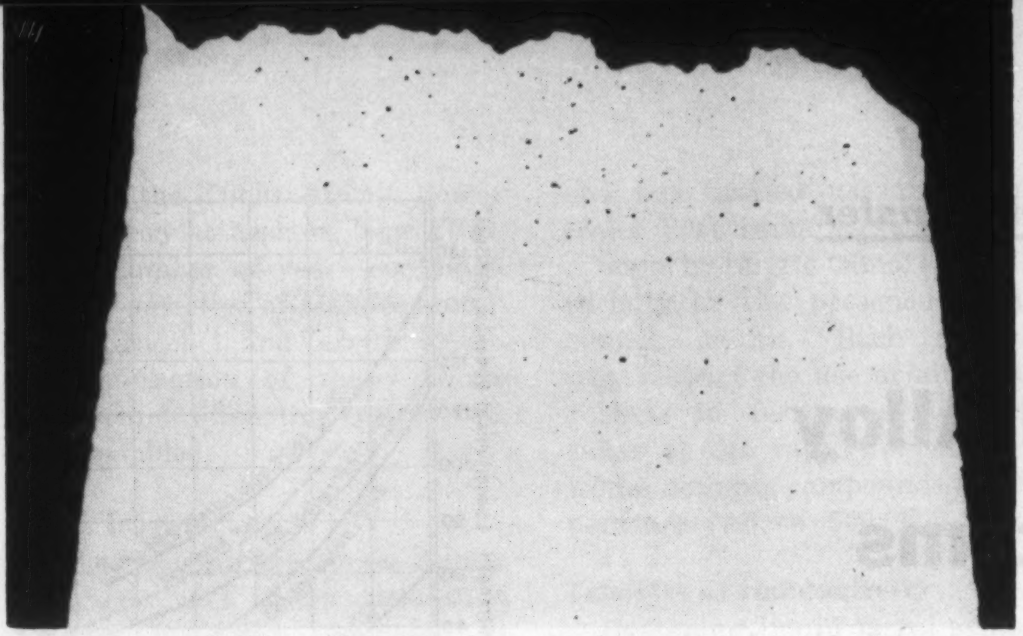


Fig 3—Porosity in necked region of a tensile bar.

from longitudinal properties, but do show greater variability (see Table 2).

The increase in tensile strength at all temperatures caused by 60% cold rolling is also shown in Fig 1. (Cold rolling more than 60% produces pronounced edge cracking and often results in failure.) It is perhaps surprising that longitudinal and transverse tensile strengths do not differ by more than a few thousand pounds per square inch even after 60% cold rolling (Table 2).

COMPOSITION OF ZIRCALOY-2 STRIP, BARS AND FORGINGS

Typical composition[a], % by wt	
Tin	1.3 –1.6
Iron	0.07–0.20
Chromium	0.05–0.16
Nickel	0.03–0.08
(Fe+Cr+Ni)	0.23–0.32
Nitrogen (max)[b]	0.006
Impurity content, max ppm[c]	
Aluminum	50
Boron	0.5
Cadmium	0.5
Carbon	500
Cobalt	10
Copper	50
Hafnium	200
Lead	100
Magnesium	20
Manganese	50
Molybdenum	50
Silicon	100
Titanium	50
Tungsten	50
Vanadium	50

[a] *Specification PDS 11538-4.*
[b] *Given as part of composition because of nitrogen's importance in corrosion resistance.*
[c] *Limits not set on hydrogen and oxygen. Hydrogen usually runs about 40-50 ppm and oxygen about 1400-2500 ppm. Oxygen has a strengthening effect at ambient temperatures but this effect decreases with increasing temperatures.*

As Fig 1 indicates, the effects of temperature, annealing and cold work on yield strength parallel those shown for tensile strength.

Hardness—The effect of these variables on hardness is similar to those shown for tensile strength. Room temperature diamond pyramid hardness in the hot rolled, annealed and cold rolled conditions is shown in Fig. 1.

Two factors affecting hardness of zirconium and its alloys must be kept in mind. First DPH values are strongly dependent on load, although load dependence vanishes rapidly as temperature increases. The values given here are based on a test load of 30 kg. Second, the hardness on planes parallel to the rolling plane may be as much as 20 DPH units higher than the hardness on transverse or longitudinal cross sections. The degree of anisotropy can be determined from the shape of the impression.

The effect of temperature on hardness is also shown in Fig 1. The parallel between hot hardness and tensile strength is apparent and may be expected to continue to still higher temperatures (data for temperatures up to 1470 F are available). Plotting the logarithm of DPH against temperature produces a sequence of two straight lines, with the sharper, downward slope starting at 1020 F.

Three measures of ductility are plotted as a function of temperature in Fig 2. These curves are not as smooth as the strength curves, and variability of ductility measurements is usually greater than that of corresponding strength measurements.

Uniform elongation—The curves for uniform elongation are the smoothest of the ductility curves. When true stress is plotted against natural strain on log-log paper, the stress-strain curve for Zircaloy-2 becomes nearly a straight line. Hence, the power law ($\sigma = K\delta^n$) is a good approximation of the plastic behavior of this alloy, and uniform elongation is very nearly equal to the work hardening exponent "n". The curves in Fig 2 show that uniform elongation generally decreases with both increasing temperature and increasing cold work; however, uniform elongation of 60% cold rolled material remains constant above room temperature.

Reduction in area—Although reduction of area shows an overall increase with temperature, this tendency is interrupted in the 300-650 F range, depending on the amount of cold work (see Fig 2). Such behavior is reminiscent of the blue-brittle range in the low- and medium-carbon steels. The decrease in ductility at these elevated temperatures is more pronounced in the transverse direction. In material cold worked more than 25%, transverse reduction of area rises sharply again at about 750 F.

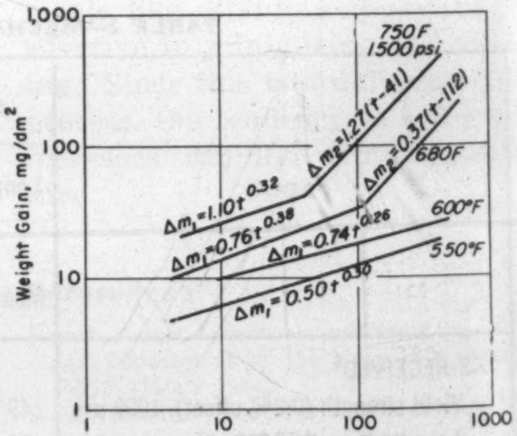


Fig 4—Weight gain vs time of exposure in high temperature water and steam. Specimens exposed at 550, 680 and 750 F were previously annealed below 1470 F. Specimens exposed at 600 F were in hot rolled condition.

Although the reason for a deficiency in ductility at elevated temperatures is not known, hydrogen is a suspected cause. Good ductility above this temperature can be explained by the fact that the alloy can take into solution its usual concentration of hydrogen (40-50 ppm) at about 750 F, thereby eliminating any detrimental effect of hydrogen on ductility. It takes only a small amount of hydrogen in the form of hydrides to greatly reduce the necking strain of zirconium, and a similar effect is expected in Zircaloy-2. Considerable porosity occurs in the necked region of a tensile specimen containing 45 ppm of hydrogen and tested at room temperature (see Fig 3), presumably because of hydride precipitation and triaxial strain. Note also that the cup-cone failure typical of "ductile" material does not occur. The effect of small amounts of hydrogen is particularly important in view of the tendency of Zircaloy-2 to pick up hydrogen in corrosive environments. Ductility of Zircaloy-2 can probably be increased by inhibiting the formation of pores, i.e., preventing the precipitation of hydride.

Impact energy—Small amounts of hydrogen also have a pronounced effect on impact strength. The two impact energy curves in Fig 2 are based on material containing 45 ppm of hydrogen. If 10 ft-lb is arbitrarily selected as the criterion for ductility, the beta-quenched (heated 1 hr in helium at 1850 F and water-quenched) material has a transition temperature of −60 F, whereas an aging treatment (3 hr at 750 F, followed by furnace cooling) increases the transition temperature by about 350 F. It has been shown metallographically that this increase in transition temperature is associated with a formation of hydride. Increasing the hydrogen content of Zircaloy-2 to 410 ppm raises the transition temperature to nearly 570 F.

Impact data alone are not sufficient to establish whether the beta-quenched condition benefits ductility. One of several other factors that must be considered is the possibility of beta-grain growth during heating prior to quenching. When large beta grains are quenched, it is quite common for separation along prior-beta grain boundaries to occur during deformation. This phenomenon has been encountered in conjunction with shrinkage stresses resulting from welding.

Corrosion properties

Unalloyed zirconium forms a film of zirconium dioxide that is tightly adherent for some time, then becomes non-adherent. The time at which the first period is interrupted is highly variable and is shortened by the presence of small amounts of nitrogen or other impurities in the metal. The corrosion rate in the first period is quasi-cubic, whereas in the second period it is linear and very high.

The principal advantages of Zircaloy-2 are: 1) the time at which the first period is interrupted is highly reproducible and relatively insensitive to impurity content (which makes possible the use of Kroll process sponge zirconium in Zircaloy-2), and 2) in the second period, the corrosion product is adherent and the corrosion rate is low. These advantages become more pronounced with increasing temperature.

Since the corrosion-produced oxide remains on the surface, the corrosion of Zircaloy-2 can be measured by its increase in weight. In the first period, the empirical equation is:

$\Delta m=kt^n$

where Δm is weight gain
t is exposure time
k and n are constants dependent on temperature

In the second period, the empirical equation is simply:

$\Delta m=kt$

Empirical curves for several exposure conditions are plotted on logarithmic scales in Fig 4. The transitions for exposures at 550 and 600 F are not shown since experimental data for very long exposures are not available; however, such transitions can be estimated.

Note that Zircaloy-2 seems to follow the same corrosion pattern in superheated steam as it does in water at lower temperatures. It has also been found that the effects of composition variations on corrosion are the same in steam as in water, and therefore it is possible to use steam exposure as an accelerated corrosion test.

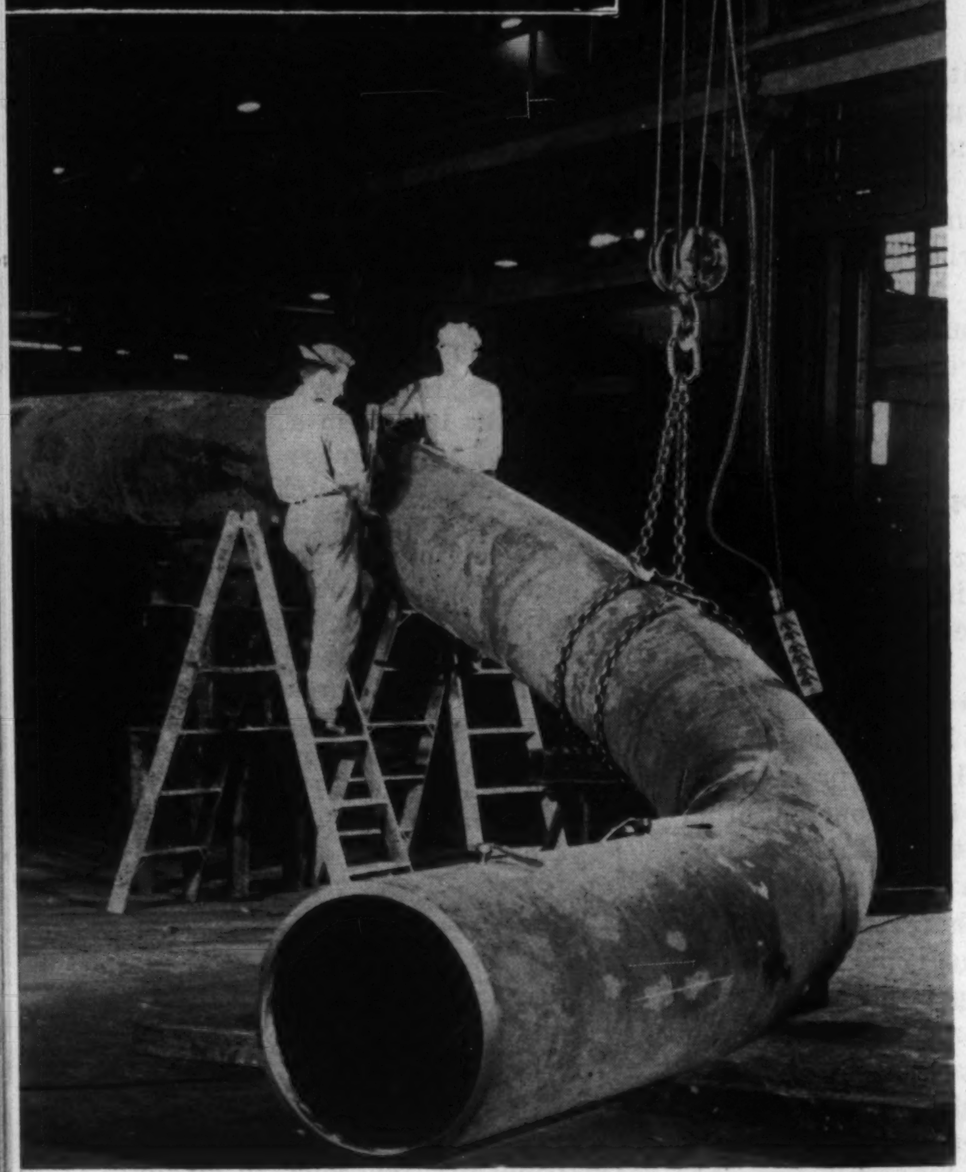
Transformation Temperatures

Hot-rolled Zircaloy-2 requires a temperature of 1470-1560 F for complete recrystallization within 30 min. The laboratory annealing treatment consists of 20 hr at 1380 F in a vacuum, followed by furnace cooling. Annealing in the alpha range for any reasonable time does not result in grain growth. On heating the alloy, at the rate of 180 deg F per hr, a eutectoid reaction, probably involving iron, nickel and chromium, begins at about 1520 F, and transformation to the beta phase begins at about 1650 F. On cooling, reverse reactions end at 1440 and 1590 F, respectively.

Here are other facts about Zircaloy-2:

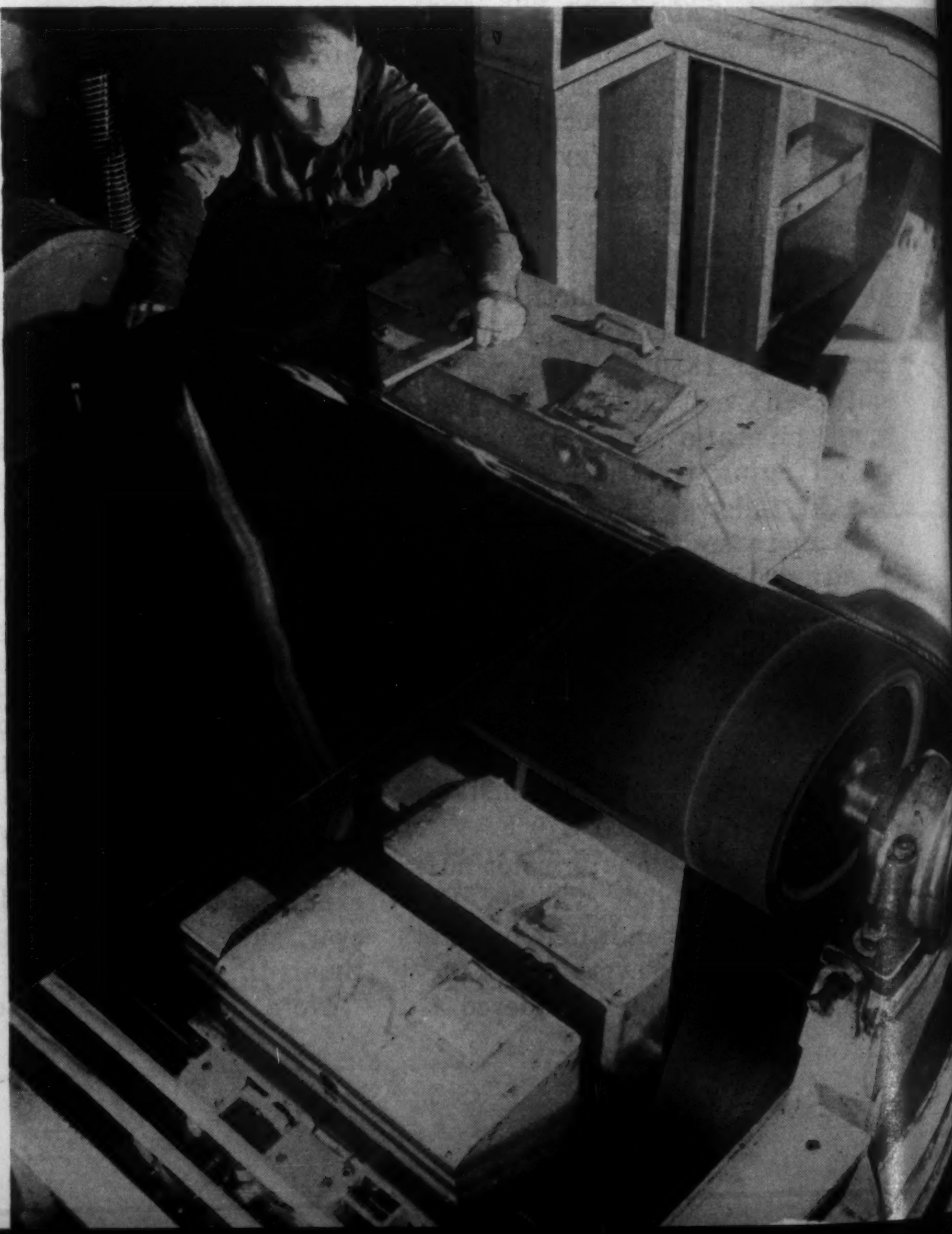
1. Since the corrosion properties of Zircaloy-2 are relatively insensitive to composition, reasonable variations from the nominal composition need not cause concern.
2. Data for exposure in 680 F water and 750 F steam indicate that annealing at temperatures as high as 1650 to 1800 F results in somewhat higher corrosion rates than lower temperature annealing. Corrosion properties are not particularly affected by cooling rate.
3. Hydrogen pick-up of Zircaloy-2 in hot water seems to be proportional to the rate of corrosion. However, the corrosion rate increases only gradually as the initial hydrogen content of the metal is increased.

This article is adapted from a paper to be presented as an AIME contribution to the Nuclear Engineering and Science Congress in Cleveland this month.



Big high temperature pipe

Five different heats were required to give this 30 ft section of fusion-welded chromium-molybdenum alloy pipe a 90 deg bend and an offset of 24 deg, 18 min on an 11-ft radius. With a 27-½ in. o.d. and a 1-½ in. wall thickness, the pipe will be used at a generating station for 475 lb steam reheat at temperatures of 1050 F. Fabricators, Power Div., Blaw-Knox Co. of Pittsburgh, photomicrograph pipes as they arrive from the mill and after final assembly to ensure against failure.



X-rays measure tin plate

X-ray gages have been installed to check thickness of tin plate on both sides of sheet steel as it moves over this roller at Jones & Laughlin Steel Corp. Gages are capable of measuring coating thickness to within 6/10,000,000 in., at speeds up to 2000 ft per min. Worker is measuring distance between sheet and gage.

(General Electric Co.)

Industrial Textile Fibers

by **Theodore B. Merrill, Jr.,** *News Editor, Materials & Methods*

MATERIALS & METHODS MANUAL No. 122

This is another in a series of comprehensive articles on engineering materials. These sections provide the reader with useful data on characteristics and uses of materials, parts and finishes.

Textile fibers are engineering materials. But not until recent years—since the rapid development of synthetics—have they been treated as such.

This manual takes the engineering approach to the selection of, and designing with, fibers. It covers the characteristics, properties and uses of:

- *Natural fibers*
- *Mineral and inorganic fibers*
- *Man-made fibers*

(E. I. du Pont de Nemours & Co.)

***High-strength nonwoven felts** are made from Dacron polyester fiber.*

Introduction

Until recently, selecting the right textile fibers or industrial textiles for products of industry has been largely empirical. Historically, the engineering approach has been more concerned with production techniques for making yarns and fabrics than with the basic relationships of material properties to the final product, because the raw materials were static.

However, the tremendous technological breakthrough represented by the production of man-made fibers has drastically altered this. It has provided the basis for use of the engineering approach to the selection of, and designing with, fibers and textiles. Now, new fibers can be designed for specific applications, rather than existing fibers adapted by different means of mechanical spinning and weaving.

However, the vast markets, equipment, experience, tradition and skills represented by the textile industry did not, cannot, and will not switch overnight to conform to the terminologies and testing techniques of materials engineering in other fields. Fibers will be sold by denier indefinitely, for example, although the term, which refers to the thickness of a given fiber when 9000 meters of it weigh one gram, will never be as clear to the non-textile engineer as a simpler area or diameter figure or even a directly proportional gage system. Some improvement is offered by the grex system, in which a 1-grex yarn is 10,000 meters of fiber or yarn which weighs one gram. Similarly, tenacity will continue as a measure of fiber strength, although it is now common to include tensile strength as well in most technical bulletins.

Natural fibers

The natural fibers are not only the oldest, but are the most common and abundant textile materials. Cotton, bast and hard fibers are inexpensive, and the single important animal fiber, wool, has some properties that cannot be duplicated in a man-made fiber.

There are few generalities that apply to all natural fibers. All natural fibers except silk occur in the form of staple, and must be spun into yarn, felted or bonded to produce a cohesive structure.

The most important natural fibers for industrial purposes are cotton and wool, and they have been given special attention as individual fibers in this manual. For the balance of the natural fibers, a discussion of general properties of their class, with specific data on a few of the more important and interesting fibers within the class should provide sufficient information to indicate potential applications.

In general, natural fibers are less costly than man-made fibers. Natural fibers are subject to greater price variations, however, due to the rigid nature of their sources. Most of the bast and hard fibers are not available from domestic sources. Since nearly all natural fibers involve a considerable amount of hand labor and agricultural space for production, the general trend of natural fiber prices is to rise with the world's living standards, while the price of man-made fibers tends to come down as production techniques improve and quantity increases.

Due to relative scarcity and comparatively high cost per pound, few animal fibers are now of real importance for industrial textiles. Wool is the outstanding exception, of course. Other animal fibers, such as horsehair and bristle, face heavy competition from synthetics. Horsehair has diminished in availability with the reduction in horse population, and Chinese hog bristle, of which the best paint brushes are made, is no longer available in adequate quantities. Generally, animal fibers have less tensile strength than vegetable or synthetic fibers, but make up for this deficiency in excellent resiliency and energy absorption qualities. Animal fibers are more resistant to acid environments than vegetable fibers, but do not have as much alkaline resistance. All animal fibers will support combustion, but will not burn as readily as cellulosic materials.

Mineral and inorganic fibers

As a class, the inorganic fibers share several characteristics. All have quite high tensile strength, but are very poor compared to natural or synthetic organic fibers in abrasion resistance, spinnability, and toughness. Only two, glass and crysotile asbestos, are spinnable enough to make really satisfactory yarn. The mineral fibers have a greater temperature range than organic materials, as might be expected, and they have good resistance to acid environments, with one or two exceptions.

Man-made fibers

In addition to providing new basic materials for textile products, the manufacturers of man-made fibers have control over both chemical composition and physical form of the fibers themselves. Because man-made fibers are produced under controlled conditions, they can be tailored for maximum performance qualities for specific uses. Man-made fibers have much more uniformity, permitting textile operations to work to closer tolerances in yarns and fabrics. Almost all of the man-made fibers are available in continuous filament form. The filaments are chopped into staple for spinning, are spun into filament yarn, or in some cases the monofilament itself is used for weaving, producing a smooth and permeable textile structure.

In the accompanying box is a short glossary with a few conversion factors that may be helpful. In the tabular data in this manual, tensile strength was listed rather than tenacity, fiber width in microns instead of denier. Such figures as stiffness and toughness are so closely allied with the textile industry terminology that conversion to English units would be confusing, particularly since the data are more useful as comparative than as absolute values.

Some Basic Definitions

Filament—A continuous fiber.

Monofilament — A continuous fiber of sufficient size to serve as yarn in normal textile operations.

Staple—Fibers of particular length.

Sliver—A number of staple or filament fibers aligned in a continuous strand without twist.

Roving—A loose assemblage of fibers drawn or rubbed into a continuous strand with very little twist. A stage between sliver and yarn.

Yarn—Twisted fibers or filaments in a continuous strand suitable for weaving, etc. Ply yarn is formed by twisting two or more yarns together. Ply yarns are in turn twisted together to form cord.

Fabric — A planar structure produced by interlacing yarns, fibers, or filaments.

Knitted fabrics are produced by interlooping strands of yarn, etc.

Woven fabrics are produced by interlacing strands at more or less right angles.

Bonded fabrics are a web of fibers held together with a cementing medium which does not form a continuous sheet of adhesive material.

Felted fabrics are structures built up by the interlocking action of the fibers themselves without spinning, weaving or knitting.

Count—The number of warp yarn (ends) and filling yarns (picks) per inch.

End — An individual sliver, roving, yarn or cord. In a fabric, an end is a warp yarn (running the length of the fabric).

Pick — An individual filling yarn (running the width of a woven fabric at right angles to the warp). In England it is termed woof or weft.

Denier—A yarn and filament numbering system in which the yarn number is equal numerically to the weight in grams of 9000 meters. Used for continuous filaments.

Grex—A universal yarn numbering system in which the yarn number is equal numerically to the weight in grams per 10,000 meters.

Other yarn numbering systems—Yarn sizes are expressed in terms of linear density.

Cut = number of 100 yard lengths per pound (asbestos, wool, glass).

Typp = number of thousands of yards per pound. (cotton, rayon, wool).

Spyndle = weight in pounds of 14,000 yards of yarn (jute).

Hank or lea = number of 300 yard lengths per pound (linen). Number of 840 yard lengths per pound (silk).

Tenacity—The ultimate tensile strength of a fiber, filament, yarn, etc. usually expressed in grams per denier.

$$\text{Tenacity (G.P.D.)} = \frac{\text{Tensile str, psi}}{12{,}800 \times \text{specific gravity}}$$

Tensile strength — Ultimate breaking strength in psi. In textiles, tensile strength of fibers is only one of a number of parameters relating to fabric or yarn strength. Yarns of staple fibers usually exhibit less than half the sum of the individual fiber strengths. Filament yarns have roughly the strength of the sum of the individual fiber strengths.

Vegetable Fibers

Cotton

More cotton is consumed than all other fibers put together, the U. S. alone consuming 5 billion lb per year. While most cotton goes into soft goods and consumer items, the excellent properties and low price of cotton put it in the forefront of all industrial fibers.

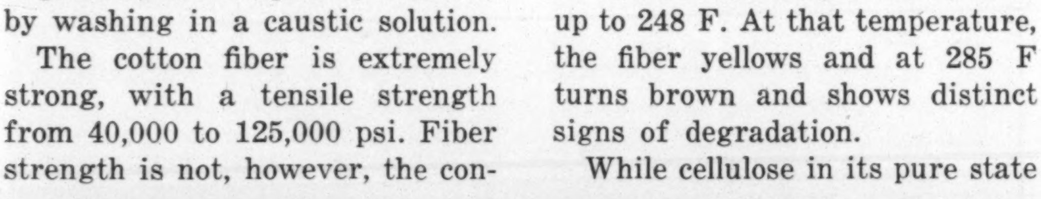
Fiber characteristics—The individual cotton fiber is a single elongated cell that grows from the outer layer of the seed of the cotton plant. At maturity, the walls of the long tubular cell thicken, and on drying out, the fiber flattens and twists into the form of a convoluted ribbon, ½ to 2½ in. long with a width of 12 to 20 microns. Desiccated cotton fiber is composed of about 95% pure cellulose, and typically contains about 5% impurities consisting of wax, pectic substances, protein and ash. These impurities are frequently removed by washing in a caustic solution.

The cotton fiber is extremely strong, with a tensile strength from 40,000 to 125,000 psi. Fiber strength is not, however, the controlling factor in fabric or yarn strength. In the case of cotton, the primary quality consideration is fiber length, since cotton yarn depends on the friction and intertwining of the fibers for its strength and permanence. Longer fibers, naturally, have more friction area than short fibers, and given the same density and degree of twist, will produce stronger yarn.

Cotton fiber possesses excellent spinning characteristics, due to both the twisting convolutions of the fibers—from 150 to 300 twists per in., and the tough, waxy surfaces of the cell, which have a natural cohesive quality as well as a high coefficient of friction. It is possible to spin finer yarns from cotton than from any other fiber.

Cotton fiber is very durable under normal conditions, has a higher wet than dry strength, and is affected very little by heat up to 248 F. At that temperature, the fiber yellows and at 285 F turns brown and shows distinct signs of degradation.

While cellulose in its pure state is an extremely inert material chemically, cotton is not. It has extreme sensitivity to oxidizing agents and acids—such that under some conditions even very weak mineral acids have a tendering effect. In the absence of oxygen, cotton has very good resistance to caustic solutions, so that the fibers or yarns can be scoured at high temperature with caustic soda or soda ash without damaging the fiber.



Shown from top to bottom *are Lantuck nonwoven fabric, wadding (indicated by pencil) and vinyl. This combination was used for various upholstery items in several 1955 automobiles.*

Grades of cotton—Because both the species of plant and the climate affect the cotton fiber, cotton is graded by geographical type. Although the quality and length of the fiber varies within each type to a significant extent, no intra-type variation approaches the differences between the varieties.

Sea Island cottons are the finest cottons available. All of the several sub-varieties have long, fine and strong fibers, particularly suited for applications where the highest strength-weight ratio is needed, such as aircraft fabrics or balloon cloth. Sea Island cottons are limited in availability since they are not grown in great quantity. Their price is four or five times as high as cottons of standard commercial quality.

Egyptian cottons resemble Sea Island cottons in fiber length and fineness. The output of these cottons is closely controlled by the Egyptian Government, which carefully grades and identifies each crop.

American Egyptian cotton is grown in the Southwestern U. S. from Egyptian type cotton plants, and is a distinct variety resembling in fiber length and fineness many of the Egyptian grades.

American Upland cotton is the most important cotton crop, from a standpoint of volume and number of uses. The long staple grades, with fiber lengths from about 1⅛ to 1¼ in. are used in exacting applications for mechanical fabrics, such as tire cord and special duck for high strength

NATURAL FIBERS

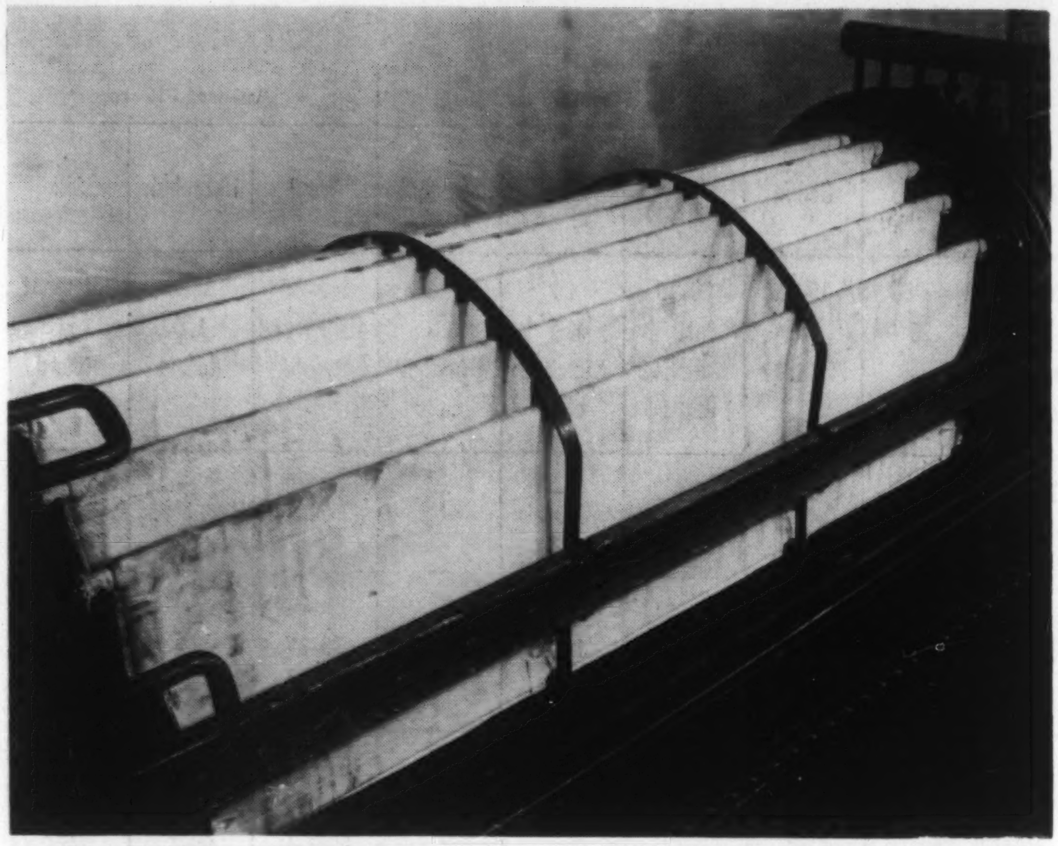
Properties	Cotton	Bast Fibers				Hard Fibers			Animal Fibers		
		Flax	Jute	Hemp	Ramie	Manila (Abaca)	Sisal	Hennequin	Wool	Horsehair	Silk
Fiber length, in.	½–2½	6–40	10–60	40–80	15–25	20–40	24	20	1½–15	1–25	Filament
Fiber width, avg microns	17	16	17	20	47	19	19	20	28	100	11
Cross section	Flat tube	Tube	Bunched cells	—	Flat tube	Bunched cells	Bunched cells	Bunched cells	Round	Round	Round
Specific gravity	1.55	1.50	1.48	1.48	1.55	—	—	—	1.30	1.30	1.6
Tensile strength											
70 F 65% RH, psi	42,000–125,000	115,000	—	112,000–132,000	130,000	125,000	100,000–120,000	—	17,000–28,000	—	45,000–83,000
Wet (%) normal	120%	—	Low	Low	High	High	Low	Low	79–97	—	75–95
Elongation (ult), %	3–10	3	—	2–6	3–6	2–3	2–2.5	—	25–50	—	13–31
Elasticity modulus	5.7–11	—	—	—	—	—	—	—	2.7–3.9	—	8.4–12.9
Stiffness, g/gx	57–60	270	185	200	167	175	127	—	3.9	—	.75–1.16
Strain recovery, at 2% strain unless noted	74% 45% at 5%	65%	74% at 1%	—	52%	—	—	—	99%+ 63% at 20%	99% 63% at 20%	74%
Toughness index (relative work to rupture)	14	6	2	4	8	7	5	—	20	—	44
Ratio yarn str to fiber str*	0.45–0.60	0.38	0.35	0.36	0.45	—	—	—	0.50–0.55	—	—
Friction coef (self)	0.30	—	—	—	—	—	—	—	0.20–0.50	—	0.26
Acid resistance											
Strong	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Resistant[1]	—	Dissolves
Weak	Poor	Poor	—	Poor	—	—	—	—	Resistant	—	Fair
Alkali resistance											
Strong	Exc	Good	Good	Good	Good	Good	Good	Good	Poor	Poor	Dissolves
Weak	Exc	Good	Good	Good	Good	Good	Good	Good	Poor if hot	Poor	Poor
Organic solvents	Resistant	Resistant	Resistant	Resistant	Resistant	Resistant	Resistant	Resistant	Resistant	Resistant	Resistant
Heat effect	Good to 275 F	Good to 275 F	—	Good to 275 F	Good to 275 F	—	—	—	Good to 212 F	—	Disintegrates at 340 F
Sunlight effect	Weakens	None	None	None	None	None	None	None	Weakens	Weakens	Weakens
Microbiological factors	Poor	Very good	Good	Good	Exc	Good	Poor	Poor	Fair	Fair	Good
Flammability	Burns	Burns	Burns	Burns	Burns	Burns	Burns	Burns	Slow burn	Slow burn	Burns
Cost/lb 1955	33¢	—	11–14¢	16–24¢	—	—	10¢	10¢	$1.20–$1.50	—	$4.50

* *This figure can vary to extremes with differing yarn constructions.*
Data from Barker, J. Textile Inst. Vol. 70, pp 273.
[1] *Except hot* H_2SO_4.

service. Cotton below the long staple grades, with fiber length ranging from ⅞ to 1⅛ in. is used in the majority of industrial fabrics.

Asiatic cottons have short, crinkly fibers about ½ in. long and are used in applications where a felting characteristic is needed or a napped fabric is necessary. Frequently, Asiatic cotton is mixed with longer staple cotton in a construction known as cored yarn. The long staple lends strength and the Asiatic variety contributes napping and felting qualities.

Linters are obtained from the short staples left on the seed



(Dorr-Oliver)

Heavy twill filter cloth *has low cost and excellent wet strength.*

THERMAL CONDUCTIVITY OF FIBERS

K = BTU/hr/F/sq ft/in., at 70F

Insulation	k
Asbestos, packed	1.62
loose	1.07
Cotton	0.288
Eel grass	0.31
Felt, from cattle hair	0.26
between paper	0.27
Glass wool, batts	0.27
high grade	0.24
Hair felt	0.27
Kapok	0.24
Magnesia board with asbestos	0.51
Mineral wool, loose	0.27
Batts, loose	0.29
Batts, firm	0.30
Rock wool, loose	0.28
Silk	0.312

after the ginning process has removed the longer fibers. They are used in manufacture of chemical cellulose, or as padding or stuffing material. Occasionally, when the linters possess qualities similar to Asiatic cotton, they will substitute for imported fiber in blends for napped fabrics.

Modification of cotton fiber—Cottons can be modified in the following ways.

Mercerization. When cotton fibers are passed through a caustic bath of proper concentration, the fibers swell, assuming a more cylindrical cross section and decreasing slightly in length. Elongation is reduced, but tensile strength increases up to 10%. Absorptive properties of the fiber increase significantly, providing a more dyeable fiber that is also better suited to impregnation in the production of laminates. If the fiber is kept under tension during the mercerization process, the molecules of the fiber are aligned, giving the fiber a high luster. Mercerization reduces the flex and abrasion resistance of cotton.

Resin finishing. Treatment with resins, such as urea formaldehyde, will increase the resilience of cotton fibers.

Cyanoethylation. The reaction of acrylonitrile with cotton chemically modifies the fiber, changing its properties considerably. Partially cyanoethylated cotton is rot and mildew proof, is much more stable to heat degradation, and exhibits about 50% greater elongation before break, without loss in tensile strength.

Uses—Cotton's many desirable properties, availability and low cost have won it more industrial uses than any other fabric. It is used wherever high temperature and acid conditions do not exist. A complete list of applications cannot be given here. General fields of use include: electrical insulation; laminated plastics; plastics filler; tire cord; rubber reinforcement; filter media; conveyor and dryer belts; balloon and aircraft cloth; coated fabric bases; felt filler; asbestos binder; abrasive backing; wicks; tarpaulins; padding; roofing; acoustic damping materials; binder for asphalt; and many others.

Bast fibers

The bast fibers are obtained from stalks and stems of various plants. The fibers grow in bunches, and in the raw state are associated with gummy vegetable substances, straw, bark, lignin, and other impurities. Production of a usable fiber involves removing the vegetable impurities without injuring or weakening the fiber itself. No one has yet evolved an adequate mechanical or chemical substitute for hand labor in retting either bast or hard fibers. Most of the fibers are produced in tropical areas where low cost labor is available.

Bast fibers are characterized by long, rather stiff fibers, which are slightly more difficult to weave than cotton. In other physical characteristics, the bast fibers are similar to cotton.

Flax—Flax, the basic material for linen fabrics, is the finest of the bast fibers. It is used as a reinforcement in electrical laminates, in twine and cordage, where high strength and durability are important.

Jute—There are many varieties of jute, the most common being Indian jute, used for burlap sacks, cordage, ropes and upholstery fabrics. The jute fiber grows to a length of 14 ft, but most commercial grades are in the 4 to 6-ft range. Jute generally tends to lose strength when wet, but some species, notably Pita and Tucum fiber, have good water and salt water resistance. Curana jute, grown in Brazil, has excellent resistance to insect attack. Varieties of jute are used for packing, caulking and for sound damping applications, such as floor mats in automobiles, where a heavy cheap material is needed.

Hemp—Hemp is similar to jute, but is slightly less water resistant. It was once the chief marine cordage, but has been replaced by abaca. Present uses include rough fabrics, rugs, cordage, sacking, and plastic filler. The fiber is stronger and more durable than cotton, and slightly more expensive than jute.

Ramie—Ramie fibers are among the oldest known textile materials. They are the strongest natural fibers, have the highest tensile strength, and individual fibers are about eight times as strong as a cotton fiber. The fibers are almost pure cellulose, and are fine and white. The fiber has excellent wet strength, resists weathering, mildew and salt water. Ramie is grown domestically, and in recent years has appeared in automobile rugs, blended with nylon, and even in apparel fabrics. Hose coverings, heavy duty canvases, high strength twine, and marine bearing and gland packings are among the most common uses of ramie.

Ramie fibers are very difficult to separate from the adhesive gums of the plant. Some progress has been made in recent years in developing a chemical-mechanical retting process for use in the U. S., but most of the raw fiber is shipped to France where it is hand processed.

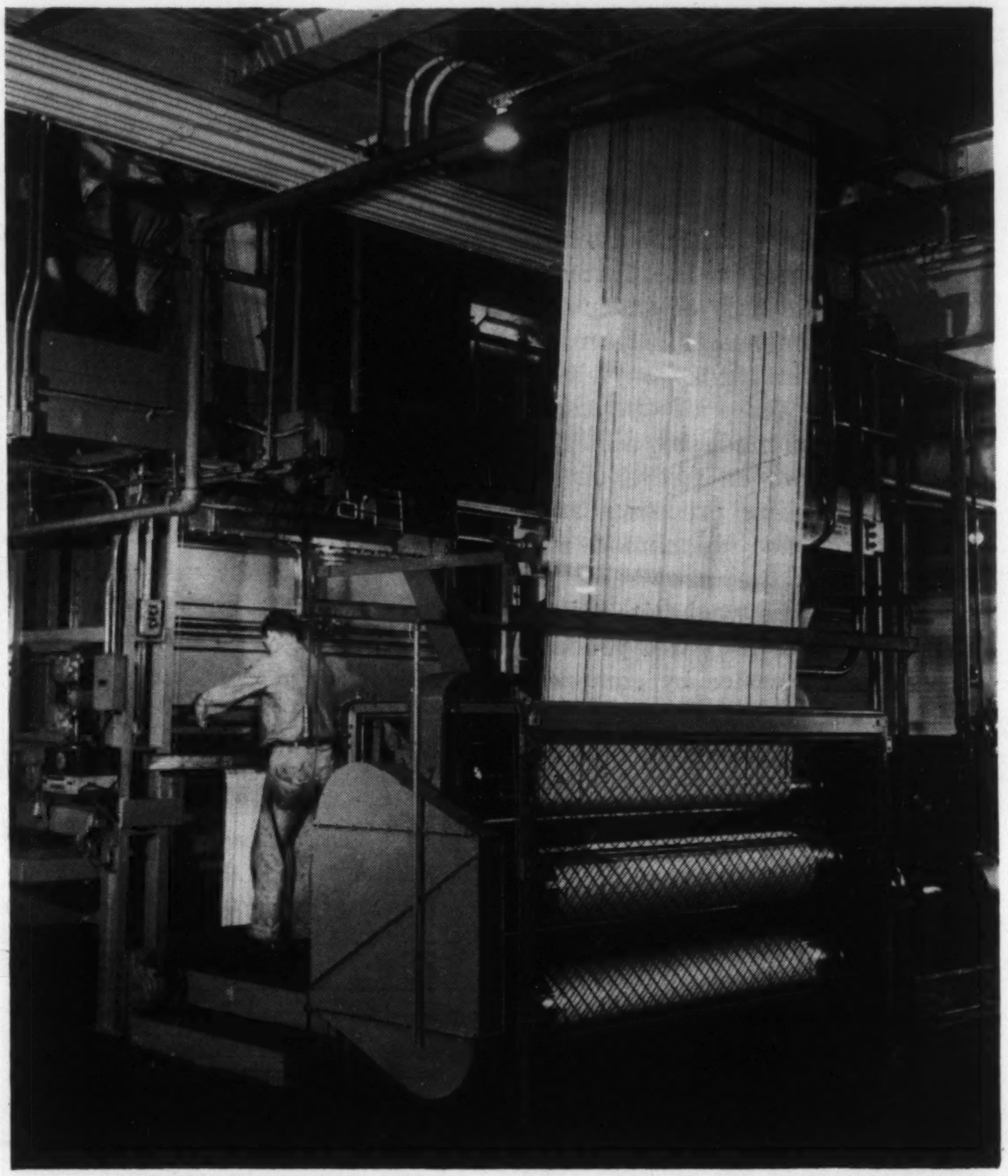
Hard fibers

The hard fibers are products of the leaves and leaf stalks of a variety of tropical plants. They are quite similar to the bast fibers in both properties and production. The principal chemical composition of the hard fibers is lignified cellulose. Manila, sisal and hennequin are the most important fibers in the group and the following hard fibers have the same general characteristics, but are slightly inferior in fiber length, strength, fineness, resistance to water, etc.: Maguey, Mauritius Hemp, Cabuya, Fique, Chuchao, Cocuiza, Pitre, and New Zealand Flax.

Manila (abaca)—Manila, Manila Hemp, or abaca is a product of the Phillipines. The long, lustrous fibers have uniform diameter and are highly resistant to sea water and rotting. The fibers do not stiffen when wet, making them ideal for cordage and marine uses. There are about 15 grades of Manila, the finest having the lightest color, finest fiber and highest strength.

Sisal—Sisal fibers are stiff and coarse, with about 75% of the strength of Manila. The fiber is low cost, and is used for most binder twine. It is a good material for mats, and is used in place of hair in cement plasters. Sisal reinforced polyester laminates are less costly than glass fiber reinforced material. Plastics premixes for compression molding containing sisal are now in wide use.

Hennequin—Grown in the West Indies, Hennequin is slightly more available than sisal from a geographic standpoint. It is similar in most respects to sisal, but is often spotted or reddish in color. Its primary use is binder twine.


(B. F. Goodrich Co.)

A web of nylon *tire cords entering calendering process, one step in tire manufactruring.*

Animal Fibers

Wool

There is probably a greater variety of industrial applications for wool than any other natural or synthetic fiber, and most of the applications are in the form of felt. Wool, the hair of sheep and goats, is the only fiber, natural or man made, that fulls—or felts—in the strict sense of the term. So-called felts made by adhesive bonding non-woven fibers, or by artificial tangling processes such as needling, are misnamed and do not have the properties or structure of true wool felts. Wool is the only fiber that will produce a cohesive structure by compressive mechanical working alone.

While there are several factors that influence felting of wool, most fiber technologists agree on the general principles of the process: that felting is a function of tangling, differential friction effect and recovery from deformation (resiliency). The wool fiber, which ranges in length from 2 to 8 in., depending on the quality and breed of animal, has a kinky, crimpy set, ideal for entanglement. The surface of the fiber is scaly—with the scales pointed from the root toward the tip of the fiber—producing a difference in the friction coefficient in the direction from root to top than from tip to root. The scales also have a barb-like effect.

The scaly and crimpy qualities combined with wool's almost remarkable ability to recover from deformation (wool has better strain recovery characteristics than any other natural fiber) result in felting if the batches of fibers are mechanically worked enough to cause extension and contraction of the individual fibers. The combination of differential friction and barb effect of the scales cause the individual fibers to move directionally in respect to surrounding fibers, producing progressively greater entanglement and fabric density.

The fulling capacity of wool fibers is such that a large amount of other fibers can be added to wool as filler. Felts with fairly good cohesion are produced with as little as 10% wool. The higher the quality and wool content of felt, however, the higher the tensile strength and density of the material. Standard mechanical felts are produced in many strengths, densities, and degrees of purity. Roll felts have tensile breaking strengths up to 500 psi, and special felts may run as high as 700 psi tensile strength. The cost of felts is a reasonably proportional relationship to strength and density.

General properties—Wool (and felt) is extremely resilient for a

PROPERTIES AND USES OF SAE WOOL FELTS

SAE grade	Recommended uses	% Wool content	Approx dens ¼-in. felt, lb/sq yd	Tens str, psi	Split resist, lb/2 in. W	Trade desig
F1	Wear and abrasion resist. Uses: High strength hardness. Not for compression. Polishing pads, bushings wicks, bumpers, spacers.	95	4	500	33	Back check
F2	Same as F1, but lower quality. Any color but black or grey.	95	4	500	28	Back check
F3	Same as F1, but lower strength and quality. Grey only.	90	3.8	400	22	Back check
F5	Highest quality resilient felt. Dust shields, grease retainer washers, wicks, wipers. White.	95	3.0	400	18	Ex firm pad
F6	Same as F5. Grey.	92	3.0	275	16	Ex firm pad
F7	Same as F5. Grey.	80	3.0	250	12	Ex firm pad
F10	Grease and oil retention where felt is mechanically confined. Dust shields under less severe conditions. White.	95	2.0	225	8	Firm pad
F11	Same as F10. Grey.	92	2.0	200	6	Firm pad
F12	Same as F10. Grey.	85	2.0	100	3	Firm pad
F13	Sound deadening, chassis strips spacers, dust shields, pedal pads and mechanical purposes where abrasion and wear are unimportant. Grey.	75	2.0	75	2	Firm pad
F15	Same as F13.	55	2.0	75	2	Firm pad
F26	Packing and padding when supported. Not for mechanical.	45	1.75	—	—	Soft pad
F50	Ball and roller bearing oil retainer washers. Thin, smooth, highly accurate. Min thickness 3/64 in. Max 3/32 in. White.	95	4*	500	—	Ball bearing felt
F51	Same as F50, lower quality. Grey.	92	4*	300	—	Ball bearing felt
F55	Anti-squeak strips and lining when cemented to entire surface. Grey or black. Max thickness 3/32 in.	75	2.0*	200	—	Lining

* *Not produced in thicknesses over 3/32 in.*

fibrous material. Wool exhibits, for all practical purposes, 100% recovery from strains up to 6% extension, has an ultimate elongation of 20 to 50%, and will recover about 65% of its extension when strained 20%. The strain recovery, or resiliency, of wool is closely related to its good wearing qualities, since wool is one of the weaker natural fibers. Wool's low modulus and ability to absorb large amounts of energy provide good damping and insulating characteristics.

The physical properties of wool are not affected by normal atmospheric conditions, moisture, sun, or heat below 212 F; decomposure begins at 266 F and scorching, at 400 F. Wool will withstand dry heat between 212 and 250 F for extended time without losing its structure, although at this temperature range there is considerable strength loss.

Chemical resistance—Wool is resistant to most strong and weak acids even when heated, but will decompose in hot sulfuric acid. Alkalies destroy wool rapidly. Very weak alkali solutions swell wool fibers and enhance their felting characteristics. Organic solvents have little or no effect on wool.

Modification of felt—Normally, felt does not exhibit wicking characteristics for water, but treatment with wetting agents will improve wetting with little effect on the other properties of the fiber. Impregnated with a water resistant, non-leeching, flexible resin, the fibers can be made water-repellant without rendering the fabric or felt impervious to water. Wool can be similarly treated with compounds rendering it insect proof, mildew proof and shrink resistant.

Applications—Wool in the form of felt has a great many industrial applications. It is an excellent friction material against smooth surfaces, is used as padding in jaws of clamps, as a brake lining, for tension adjusting washers, and as a grinding and polishing medium. As a cushioning material, felt is used as backing for abrasive wheels; as vibration isolating pads in machinery; as internal lining and cushioning for racks and tote boxes; and as a gasketing material for setting glass. It is a very stable spacing medium. Felt seals are used for grease retention, valve stem packing, and gage glass packing for oil, water and steam gage connections. Wool felt is a selective wicking material and is often used to lead oil to bearings; in ink feeds; thread moistening; pigment distributing mechanisms; and so on. The non-resonant, damping qualities of felt fit the material for many acoustic and vibration insulation applications.

Silk

Silk is the only natural fiber that occurs in filament form. It is closely related to cellulose chemically, but resembles wool in structure. Before synthetic fibers were available, silk was an important industrial, as well as apparel fiber. Today it has been replaced to a great extent by nylon, acrylic and other synthetic fibers. Silk burns completely, which makes it a useful fabric for cartridge cloths. Its high price—$4.50 per lb—reflects the large amount of hand labor necessary in its production.

Mineral and Inorganic Fibers

Glass

As a man-made fiber, the chemical composition of glass is controllable, as are the size and length of the filaments. Although glass fibers have tensile strengths higher than any other fibers, they have very poor extensibility. Glass has extremely high resistance to compression, so that when it breaks, it always breaks in tension.

Glass has extremely low tolerance for abrasion, particularly abrasion of glass fiber against glass fiber. Glass fibers must be lubricated with sizing if they are to be spun into yarn or gathered into slivers for use as roving. Usually, the sizing must be removed if the fiber is used as a reinforcing material in plastics, and a chrome salt or silane compound compatible with the resin substituted as a fabric finish.

Glass is stable to moisture, most acids, and all organic solvents. It is only slightly soluble in water, but due to the large surface area of fibers, this slight solubility should be considered in applications requiring a long lifetime in an aqueous medium. Strong alkalies and hot, weak alkalies attack glass fibers rapidly. Aging, sunlight, humidity, heat below 600 F, microorganisms and insects have no effect on glass.

Glass fibers have excellent electrical resistivity and are widely used as electrical insulation both bonded and unbonded. Since glass fiber alone is not a continuous medium, other electrical properties such as arc resistance usually depend more upon the impregnating medium used with the glass fiber than on the fiber itself. The dielectric constant of non-reinforced glass fiber is 5.8 at 10 mc.

Fibrous glass is available in many forms. For general packing, insulation and plastics reinforcement, it is produced in mats and bats of staple up to 18 in. long. For electrical insulation and plastics reinforcement where a more cohesive structure is needed, it is available in the form of roving, or loosely bonded staple sliver. Yarns are woven of both staple and continuous filament glass fibers. The least expensive form of glass is in loose staple form, and the most expensive, naturally, is woven fabric.

Insulation material of glass fibers drawn so fine that they can be calendered from a liquid into paper-thin felts is one of the newer glass fiber developments. Fine glass papers of borosilicate glass or quartz fibers have good high temperature properties for

MINERAL FIBERS

Properties	Glass			Asbestos			Ceramic
		Micro					
	Std	Quartz	Glass	Chrysotile	Crocidolite	Amosite	Alumina-Silicate
Composition	—	Silica glass	—	Hydrous magnesia silicates	Hydrous NA + Fe silicates	Fe + Mg silicate	—
Impurities, %	0	0	0	Fe, Cr, Ni, Lime	Fe	Fe	0
Color	Blue-white	Tan	—	Green, grey, white	Yellow-brown	Yellow-brown	Opaque white
Fiber length, in.	Filament or staple	Staple	Staple	Crude ⅜–¾	Crude ⅜–¾	2 in. to 11 in.	Very short
Fiber width, avg microns	5–16	0.75	0.05–1.5	0.1	—	—	3
Specific gravity	2.54	—	2.54	2.4–2.6	3.2–3.3	3.1–3.25	—
Tensile strength	205–212	—	—	80–100	100–300	16–90	Not appl
Elongation	2–3.7	—	—	Low	Low	Low	Not appl
Spinnability	Fair	Used as felt, paper	Used as felt, paper	Very good	Fair	Fair	Used as felt, paper
Abrasion resistance	Poor	Poor	Poor	Fair	Fair	Fair	Poor
Moisture absorp, %	0.1	0.1	0.1	Contains 14% —H_2O	—	—	—
Specific heat	0.157	—	0.157	0.266	0.201	0.193	—
Thermal conductivity, 1000 BTU/hr/sq ft/in./F	—	0.4–1.2 (felted) $3\ lb/ft^3$	—	1.17 at 75 F	—	—	.23–1.4 (felted)
Vol resistivity	2 x 10^{11}	10^{15}	2 x 10^{11}	—	—	—	High
Acid resistance	Resists all but HF and hot phosphoric	Resists all but HF and hot phosphoric	Resists all but HF and hot phosphoric	Soluble to 57%	Good	Fair	—
Alkali resistance	Dissolves in strong	Dissolves in strong	Dissolves in strong	Good	Good	Fair	—
Heat resistance at:	Exc to 600 F	—	—	Fair, embrittles	Loses water at mod temp	Fair, embrittles	Little effect, keeps resilience
600 F	Softens	OK	Softens	8.4% loss in tensile str	Embrittles, loses character	Embrittles, loses character	OK
800 F	NG	OK	—	26.7% loss in tensile str	"	"	OK
1000 F	NG	Shrinks slightly	Max (as felt)	40.5% loss in tensile str	"	"	OK
1200 F	NG	Shrinks slightly	NG	68% loss in tensile str	"	"	OK
2000 F	NG	Shrinks slightly	NG	Embrittles, loses character	"	"	OK—Still resilient
Fusing temp	1500 F	2500 F	1500 F	2770 F	2180 F	2550 F	to 2800 F

** Available in block, felt or paper form only.*

insulation and dry filtration. Properties of these fibers are listed in the chart under "microfibers."

Mineral wools

Vitreous fibers made by blowing steam through molten rock or rock-slag mixtures are known as rock wool, and are used almost exclusively as an insulating medium. The material gains its insulating qualities largely from the entrapped air. Many proprietary varieties are produced, with maximum temperature limitations ranging from 1000 F to 1700 F. Most mineral wools contain some shot-like particles of vitreous material which do not interfere with most applications, but generally preclude the production of fine felts or very thin bonded constructions.

Ceramic fibers

Fine, shot-free fibers of aluminum silicate, developed only recently, hold excellent promise of becoming a highly important new insulating medium. The fibers are very fine, and do not lose resiliency in temperature as high as 2300 F. They are opaque to infra-red radiation, which is a factor of increasing importance at temperatures over 1000 F. At present, the aluminum silicate fibers are only available in felted form as paper, or as loose staple. The fibers are difficult to produce in lengths sufficient for spinning. In felted or bonded form, the ceramic fibers are effective in both acoustic and thermal insulation applications. The unbonded felt is very weak, and the bonded felt is not suitable for high temperature structural use, as the bonding medium burns out at about 300 F. Without external stress, the felt, or paper, will hold its form and insulating properties well above 2000 F. Its thermal conductivity at 2000 F is only about 1.3 Btu/hr/sq ft/in., and at 200 F is less than 0.4. Besides high temperature thermal insulation, the ceramic fibers are used for electrical insulation, as a separator in hot coining and hot pressing, for arc shields, and hot gas filtration. Thermal efficiency, light weight and fine structure make it useful for shielding the hot end of jet engines in aircraft.

Asbestos

Asbestos is a generic term for a number of fibrous minerals. Three types, chrysotile, crocidolite, and amosite, provide most of the commercially used asbestos fiber.

Chrysotile, a fine long flexible fiber obtained from a variety of serpentine, is a hydrated silicate of magnesia. The fibers are strong and silky, averaging about one millionth of an inch in diameter. Chysotile asbestos is the only type that is easily adapted to spinning and weaving, and is thus the material from which nearly all asbestos yarn, fabric, and cloth is woven. Chrysotile is seriously attacked by acids, however, and for acid resistant applications, some yarn is produced from crocidolite, a hornblende.

In yarn and fabric form, asbestos is used in friction facings and linings, electrical cable insulation, press pads, belting for high temperature service, high temperature pipe covering, electrolytic diaphragms, protective clothing, vacuum bags, mailbags, as packing for expansion joints, gaskets, filters and other products.

Asbestos textiles are usually graded according to asbestos content and service temperature as follows:

Grade	*Asbestos Content, %*	*Service Temp, F*
Commercial	75-80	400
Underwriters	80-85	450
A	85-90	550
AA	90-95	600
AAA	95-99	750
AAAA	99-100	900

To lend greater strength and flexibility to asbestos textiles, natural and man made organic fibers are blended with the asbestos. The longer staple of the natural fibers provides good strength and cohesion, but service temperature is limited by the supporting non-asbestos fiber.

Man Made Fibers

Regenerated fibers

Rayon fibers are classed as regenerated fibers, since they are manufactured from compounds resulting from chemical treatment of natural cotton and wood fibers.

Rayon—Viscose rayon is a cellulosic material, similar in chemical properties to cotton. It is produced from wood pulp and/or cotton linters.

The most important industrial viscose fiber is high tenacity rayon. A tensioning process during fiber treatment produces a molecular alignment resulting in higher tensile strength. High tenacity rayon has supplanted cotton in many high performance tire cord fabric applications, V-belts, and rubber hose. In acid and alkali resistance, all cellulose rayons resemble cotton. They are also subject to mildew. Regular and high tenacity rayons are sensitive to moisture, and maintain only 45-55% of their strength when wet.

Cellulose acetate—Cellulose acetate fibers are known as acetate rayon, although cellulose acetate is quite different from the viscose from which the other rayons are manufactured. Cellulose acetate is an ester of cellulose, and fibers are formed in a dry spinning process. Cellulose acetate fibers differ from viscose rayon in the important respect that they are resistant to microbiological attack.

Fortisan 36—A highly oriented saponified cellulose acetate fiber, has exceptional strength and toughness, and is particularly adapted for reinforced rubber applications. It has slightly greater moisture resistance, losing only 30 to 35% of its strength when wet. The dimensional stability of Fortisan 36 is also exceptional, and the material is used in plastics laminates as a reinforcing

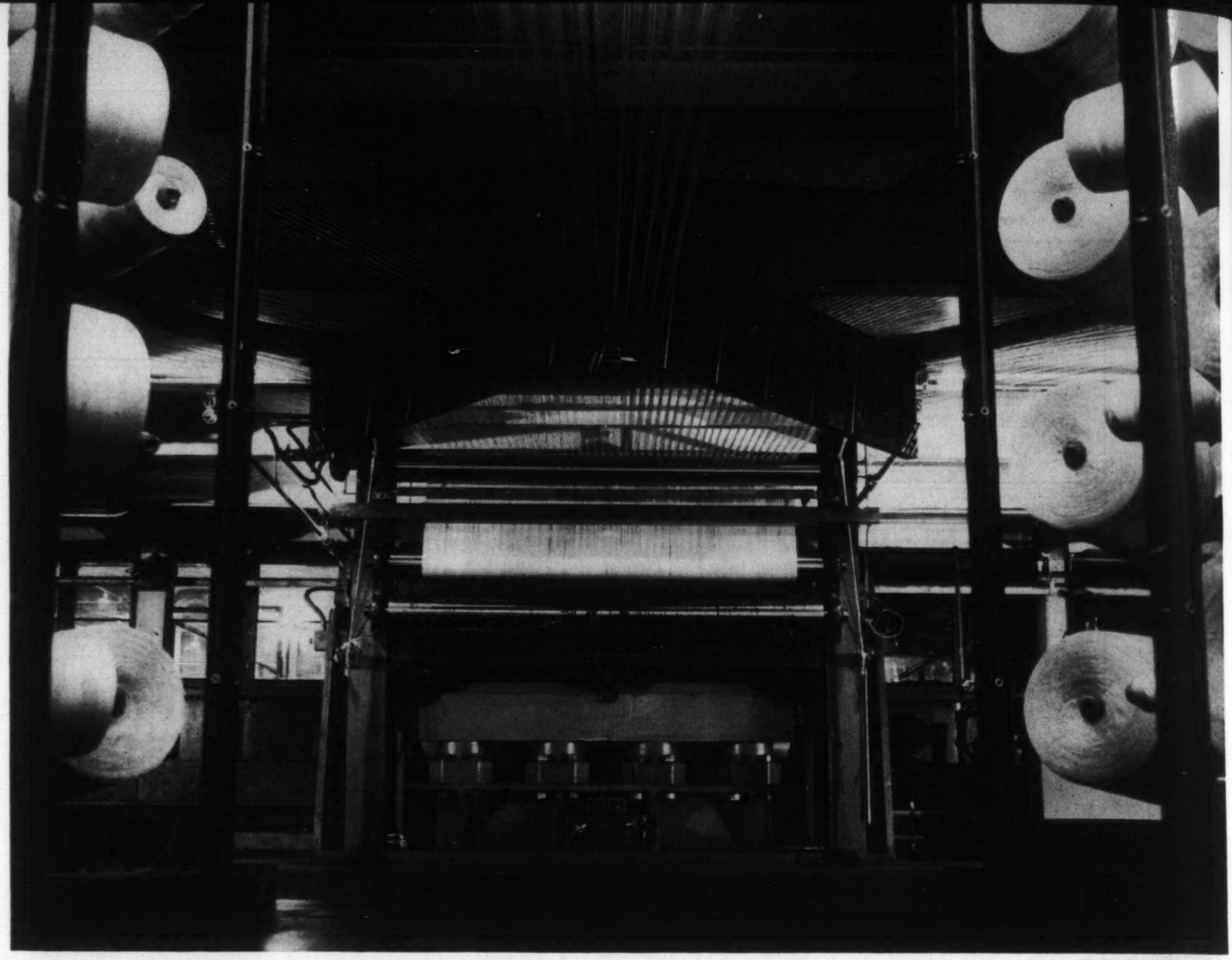
SYNTHETIC FIBERS

Properties	**Regenerated Cellulose (Rayon)**				**Cellulose Acetate (Acetate)**	**Nylon Type 66**			**Fluorine Fibers**
	Viscose		Cuprammonium	Fortisan 36					Teflon
	(high tenacity[1])	regular				Reg	High	Staple	
Composition	Regenerated cellulose		Regenerated cellulose	Saponified cellulose acetate	Cellulose acetate	Polyamide			Polytetrafluorethylene
Color	White		White	White	White	White			Brown
Fiber width avg (microns)	10–15	10–43	11	—	11–46	10+			—
Cross section	Irregular		Circular	Irregular	Irregular	Circular			Circular
Specific gravity	1.5	1 5	1.54	1.52	1.3	1 14			2.3
Tensile strength 70 F 65% RH, 1000 psi	85–95	29–47	33–42	138–155	20–25	67–85	89–108	60–66	44
Wet, % of normal	55–65	44–54	59	65–70	60–65	100	100	100	100
Elongation (ult), %	10–20	15–30	10–17	6.2	23–30	26–32	19–24	37–40	24
Elasticity modulus	9.9–23.6	6.4–9.1	9.2	—	3–5	2.3–3.8	2.3–3.8	—	—
Stiffness, g/gx	25	11	14	—	5.2	20	41–47	—	—
Strain recovery, %, from 2% strain unless noted	82	82	48 at 5%	—	94	100[2] 75 at 20%	100[2]	100[2]	—
Toughness index (relative work to rupture)	25	19	14	—	19	56	52	—	Good
Friction coef (self)	0.19		—	—	0.29	0.14–0.16			Low
Acid resistance Strong	Decomposes		Decomposes	Poor	Decomposes	Poor			Inert
Weak	Strength loss		Decomposes	Poor	Dissolved by some	Fair			Inert
Alkali resistance Strong	Swells		Swells	Swells	Saponifies	Good			Inert
Weak	Resists (cold)		Resists (cold)	Resists (cold)	Resists (cold)	Good			Inert
Organic solvents	Resists		Resists	Resists	Dissolved by many	Generally insoluble			Inert
Heat effect SP = softening point MP = melting point	Str loss at 300 F		Decomposes at 300 F	Str loss at 250 F	Str loss at 194–225 F MP—400	SP—284 F MP—482 F			SP—400–525 F MP—590 F[3]
Sunlight effect	Weakens		Resistant	Resistant	Weakens	Weakens			Inert
Microbiological factors	Attacked		Attacked	Attacked	Resistant	Resistant			Inert
Flammability	Highly flammable		Highly flammable	Burns	Burns	Won't support combustion			Fire resistant

[1] *Super Cordura.*
[2] *Delayed recovery up to two weeks.*
[3] *Emits toxic fumes at 400 F.*
[4] *Available in staple form only. Staple length—1⅜–4 in. Crystallizes on heating to 176 F.*

SYNTHETIC FIBERS cont.

Acrylic Fibers				Polyester Fiber	Vinyl Derivatives			Protein Fiber
Orlon	Acrilan	Vinyon N	Dynel^4	Dacron	Vinyon	Saran	Polyethylene	Vicara
Polyacrylonitrile	Acrylic copolymer	Vinyl chloride acrylonitrile copolymer	Vinyl chloride acrylonitrile copolymer	Polyethylene terephthalate	Vinyl chloride vinyl acetate	Vinylidene chloride	Polyethylene	Zein (corn protein)
Cream	White	Light cream	Light cream	White	White	White	White	Beige-white
—	—	—	—	—	16–18	50–1300	150+	15–30
Flattened tube	Flattened tube	Flattened tube	Flattened tube	Circular	Bar bell	Circular	Circular	Circular
		Convoluted	Convoluted					
1.14–1.17	1.2	1.26–1.32	1.28	1.38	1.33	1.68–1.75	0.92	1.25
77	44–66	70–90	45–48	85–106	35–76	15–45	11–32	17.5–19
95	80	100	100	98	100	100	100	45–55
16	31	25–35	35	12–40	14–35	20–30 at break (oriented)	20–80	30–35
—	—	—	—	—	3.5–4.5	0.3–1.7	—	—
28–30	8	10	7.9	13–25	22	20	2–12	2.8–3.4
85	80	97	97	90–100	99	95	90–95 slow	99% at 4%
44	32–40	45	48	49–63	30–36	—	30	18–21
—	—	—	—	—	0.19	—	—	—
Inert	Inert	Very resistant	Resistant	Good at low temp	Resistant	Resistant	Resistant	Resistant to 10% conc
Inert	Inert	Very resistant	Resistant	Resistant	Resistant	Resistant	Resistant	Decomposes
Attacked	Attacked	Resistant	Very resistant	Fair at low temp	Resistant	Resists most	Resistant	Decomposes
Fair–Good	Fair	Very resistant	Very resistant	Good at low temp	Resistant	Resistant	Resistant	Resistant (cold)
Generally resistant	Very resistant	Good	Generally good	Resistant	Poor	Generally resistant Swells	Generally good	Resistant
SP—280 F	SP—300 F	SP—250 F	SP—250 F	SP—450 F^5	—	Str loss at 160–200 F	SP—225 F	Resistant to 310 F (short time)
MP—455 F	MP—455 F	—	MP—325 F	MP—480 F	MP—260 F	MP—270-325 F	MP—230–250 F	
Very resistant	Resistant	Slight str loss	Weakens	Weakens	Resistant	Tends to yellow	Weakens	Resistant
Resistant	Resistant	Resistant	Resistant	Resistant	Resistant	Resistant	Resistant	Resistant
Slow burn	Slow burn	Self extinguishing	Self extinguishing	Slow burn	Won't support combustion	Won't support combustion	Slow burn	Burns



(B. F. Goodrich Co.)

Some 2500 *ends of nylon tire cord are gathered together in this eyelet board to form a 66-in. wide web.*

material, in non-expanding V-belts and conveyors, and in hose for high pressure hydraulic applications. Fortisan 36 is one of the strongest fibers, and has the highest strength-to-weight ratio of all fibers.

Acrylic fibers

Orlon, a product of E. I. du Pont de Nemours, and Acrilan, a product of the Chemstrand Corp., are fibers produced from copolymers of acrylonitrile. Vinyon-N and Dynel, products of Union Carbide and Carbon, are copolymers of acrylonitrile and vinyl chloride. The outstanding properties of the four acrylic fibers are resistance to acids, mildew and fungus, fire resistance, and general resistance to most solvents. The acrylonitrile fibers are highly resistant to weathering and ultra violet, but the presence of vinyl chloride in Vinyon-N and Dynel make these fibers break down under extended sunlight exposure.

Orlon—Orlon is a soft, warm, cream colored fiber produced in two types differing significantly in tensile strength and elongation properties. Type 81 is a high tenacity fiber with an ultimate elongation of 16%. Type 41 has considerably less strength, but is more flexible, with an elongation of 22.5%. The chemical, heat and aging characteristics of the fibers are similar. Orlon is resistant to many types of environment to a surprising degree. It is very stable under humidity changes, is not affected by heat up to 248 F, is acid resistant, bacteria resistant, and is not affected by common solvents.

Orlon is thermoplastic, and has no sharp melting point. The zero strength temperature is between 284 and 338 F, while the sticking point is 455 F. Only brief exposures are possible over 300 F without causing serious degradation of the fiber. For example, Type 81 lost 37% of its strength (at room temperature) when held at 274 F for 40 days, but lost 86% of its strength when held at 302 F for 28 days. The fiber is more resistant to heat if the degradation products of the fiber are carried off by moving air or liquid. In other words, the most damaging environment for the fiber is hot, still air or liquid. Filter bags and other such applications will last longer at high heat than would the same material in a static medium. Orlon is extremely resistant to weathering even in the presence of industrial fumes. Type 81 has excellent dimensional stability.

Acrilan—Acrilan is similar to Type 41 Orlon in strength characteristics, and has slightly greater elongation, improving its toughness. Acrilan has excellent acid resistance, fairly good alkali resistance, and is unaffected by benzene, petroleum, ether, acetone, ethyl alcohol, dichloroethane, carbon tetrachloride, solvent naphtha, dioxane, and most other common solvents. It is wholly resistant to bacteria and fungi. Acrilan is produced in staple form only, with 7 to 9 crimps in the fiber per inch. It has also been found that Acrilan yarn loses some strength when wet.

Vinyon-N and Dynel—Vinyon-N and Dynel are essentially the same fiber—a copolymer of acrylonitrile and vinyl chloride. Dynel is a staple fiber only, and Vinyon-N is its continuous filament counterpart. The vinyl-chloride acrylonitrile copolymer has the chemical resistance of vinyl chloride plus the good resistance of acrylonitrile. Unfortunately, it also has vinyl chloride's sensitivity to ultra violet radiation, and the fiber loses most of its strength after prolonged exposure to sunlight.

Dynel has a high degree of resistance to a wide variety of inorganic acids, bases, and salts. It is virtually unaffected by such reagents as concentrated hydrochloric acid, concentrated phosphoric acid, and concentrated aqueous solutions of sodium hydroxide. It is extremely resistant to fungus and mildew, and is fire resistant; it will burn but will not support combustion.

Dynel is resistant to most solvents, but cyclohexanone and dimethylformamide will dissolve it to some extent. Other cyclic ketones, certain amines and a few other solvents have a swelling effect on the fiber at higher temperatures. Amines such as hydrazine and pyridine have no effect on the fiber, but aniline will dissolve it. Hydrogen peroxide at 90% concentration affects Dynel fabrics only slightly.

The effect of heat on Dynel is important for industrial uses. The fiber is themoplastic, and does not have a definite melting point. As Dynel is heated, it reaches a strain release temperature at which point the fiber shrinks slightly. Further heating results in further strain release and further shrinkage until a miximum shrinkage point is reached where all strains in the fibers have been relieved. The fiber is stable to the highest strain release temperature to which it has been exposed. Woven fabrics can be shrunk to a controllable degree, producing a very tight weave. Application of heat below the strain release point can be utilized to shape the fabric—and the fabric is then resistant to change until heated to the shaping temperature again. Dynel and Vinyon-N are widely used in industrial clothing, filtration, anode bags, and other applications where resistance to chemical attack is an important factor.

Nylon

Nylon is a long chain amide polymer. In fibers, the amide chains are oriented in the direction of the fiber axis. The fiber is characterized by great toughness; it is elastic and thermoplastic, has fair resistance to dilute acids and generally good resistance to alkalies. Nylon is not soluble in organic solvents, with a few exceptions, such as boiling benzyl alcohol, hot solutions of zinc chloride in methanol, phenolic compounds, and calcium chloride in methanol. Concentrated inorganic acids will deteriorate nylon, as will concentrated formic and oxalic acid. Most bleaches have a tendering and deteriorating effect on nylon. Nylon does not lose character on aging, and is completely resistant to bacteria and fungi.

If nylon is stretched and held extended for a considerable time, it does not return to its original length immediately. The fiber instantly recovers about 50% of its elongation, then creeps back slowly recovering about 85% in the first 24 hr, and requires as much as two weeks to return to its original length.

When wet, nylon loses some strength, swells slightly and usually increases in length. Sunlight has a tendering effect after long exposure. Bright yarns are more resistant to sunlight than dull yarns. Nylon will not support combustion, and is stable in the presence of heat to 248 F at which point it softens. On prolonged exposure to heat near the softening point, nylon loses strength and turns yellow.

Nylon has the best energy absorption factor of any fiber. It increases the toughness of yarns when combined with other fibers almost in proportion to the amount of nylon added.

Nylon fabrics have "often times phenomenal abrasion resistance" according to a technical report from a large fabric manufacturer. Nylon makes an excellent and long lasting filter medium, is used in plastics laminates and many types of reinforced rubber and coated fabrics. High tenacity nylon is used in the best grades of auto truck and aircraft tires, high pressure hose, etc.

Vinyl base fibers

The vinyl based fibers—Vinyon (Union Carbide and Carbon) and Saran (Dow) are both extremely resistant to moisture, acid, and alkalies. They are both thermoplastic and quite sensitive to temperatures above 140 F. The vinyl based fibers are flame resistant.

Saran—Saran is a filament fiber produced by the extrusion of vinylidene chloride. It has one of the higher toughness indices, and its chemical properties fit it for use in filtration and for plating tank nets. It is used for automotive seat covers, radio grille cloths, window screening and marine rope. Generally, Saran is more resistant to solvents than other vinyl based fibers, and is generally resistant to all solvents except those bearing oxygen, which cause it to swell and soften.

Vinyon—Vinyon is a vinyl chloride-vinyl acetate copolymer, highly resistant to organic acids and alkalies, with excellent moisture resistance and good resistance to weathering and sunlight.

Its resistance to solvents is rather poor, since it is dissolved by aromatic hydrocarbons, ethers, esters, ketones and chlorinated hydrocarbons. Vinyon is used in filter cloths, chemical workers clothing, anode bags, plating nets and other applications demanding high resistance to water and inorganic salts, where resistance to high temperature is not required.

Polyester fibers

Dacron, a fiber manufactured by du Pont from a copolymer of ethylene clycol and terephthalic acid, combines the properties of extreme toughness, excellent elastic recovery and dimensional stability with resistance to microbiological attack, bleach resistance, exceptional heat resistance and resistance to most organic solvents. Dacron has good dimensional stability either wet or dry, is resistant to stretching, and has very good flex life.

Dacron has a narrow range of softening-to-melting temperature, as it softens at 450 F and melts at 480 F. Preshrunk Dacron yarn has an inverse relationship to temperature—it decreases slightly in length with an increase in temperature and increases in length with a decrease in temperature. Between 78 F and 266 F the dimensional change is about 0.00002 in./in./F. Heating Dacron in air has little effect on the fiber. Samples exposed to 300 F for a week showed no signs of color change or degradation.

Dacron is disintegrated by concentrated sulfuric acid, but shows good to excellent resistance to other acid media. It has good resistance to weak alkalies, but only moderate resistance to strong bases at room temperature and poor resistance to weak alkalies at high temperature. The fiber has excellent resistance to oxidizing agents and all bleaches commonly applied to other fabrics.

Dacron is a tough fiber when used alone, and is a particularly good blending fiber with wool, rayon and acetate. In its ability to increase the toughness of fiber blends, Dacron is second only to nylon. Dacron is one of the newer synthetics, but has already found wide use in such industrial applications as plastics reinforcement, ropes, tapes, filters, webbing, and as a rubber reinforcement for V-belts, conveyors, tires, and hose.

The metallic yarns which have found great use in automotive upholstery in the last few years are closely related to Dacron. The metallic threads are thin slittings of metallized Mylar, du Pont's polyester film, and are not produced in a fibrous form, strictly speaking. The metal threads share most of the qualities of Dacron fibers as far as heat and chemical resistance are concerned. Their electrical and heat conductivity is affected by the very thin layer of aluminum bonded between the sheets of Mylar before the slitting operation.

Fluorine based fibers

The amazing inertness of polytetrafluoroethelene resin is reflected perfectly in Teflon fibers. Teflon fibers and fabrics are inert to all acid and alkali reagents, to organic solvents, mineral salts, bacteria and fungi, ultra violet radiation, aging, and heat below 400 F. Teflon fibers are brown to cream colored at present, but lighter colored and even white fibers may be produced eventually. Teflon fibers are heavy, having about twice the weight per unit volume of natural and other synthetic fibers. Teflon fibers have a tensile strength of 44,000 psi, very good abrasion resistance and good flex resistance. Teflon is non-wettable, and has a slick smooth texture. It is inert to heat up to 400 F, but at that point begins to exude small amounts of toxic vapors. At its gel point, 620 F, it begins to pyrolize and gives off dangerous fumes of fluorine vapors.

Teflon fibers are very expensive and have only recently been available in experimental quantities. They are used in fabrics for gasketing, air and liquid filtration, for press covers, conveyor beltings for high temperature or corrosive service, and as plastics reinforcement.

Polyethylene

Polyethylene fibers have been manufactured in large diameter monofilament form, and have found limited use in industrial applications. The material is very resistant to acid and alkaline environments and is generally resistant to most organic solvents and other chemical reagents. Polyethylene has a low tensile strength, but very high elongation, with 100% regain from strain. Fibers made from high pressure polyethylene have low heat resistance, shrinking at 165 F and softening at 225 F. Fibers made from linear polyethylenes should show improvement in this respect. Polyethylene has a density of 0.92, lower than water, and will float in aqueous media.

Protein fibers

Vicara is a zein type fiber made from corn proteins. It is hydrophilic, and resembles wool in many respects, such as resilience, heat of wetting, combustibility. The chief uses of Vicara are in blends with other synthetic fabrics, to which Vicara lends a wool-like texture. The fiber is resistant to acid to the same extent as wool. The fiber is a little less sensitive to alkalies than wool, being resistant at room temperature to most solutions below 5% concentration.

Acknowledgements

American Cyanimid Co.
American Enka Corp.
American Felt Co.
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Bigelow-Sanford Carpet Co., Inc. (Fiber Glass Products Div.)
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MATERIALS ENGINEERING FILE FACTS

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Standard Brazing Filler Metals

AWS-ASTM Classification	Nominal Composition, %	Freezing Range		Brazing Temp Range, F	Remarks
		Solidus Temp, F	Liquidus Temp, F		
BAlSi	ALUMINUM-SILICON CLASSIFICATIONS				
BAlSi-1	Si 5, Al 95	1070	1165	1150-1185	General purpose filler metal for torch, dip and furnace brazing
BAlSi-2	Si 7.5, Al 92.5	1070	1135	1120-1140	Available only as cladding on M1A and J51S aluminum alloy core sheet
BAlSi-3	Si 10, Cu 4, Al 86	970	1085	1060-1185	General purpose filler metal for dip and furnace brazing
BAlSi-4	Si 12, Al 88	1070	1080	1090-1185	General purpose filler metal recommended in some cases for relatively high corrosion resistance
BCuP	COPPER-PHOSPHORUS CLASSIFICATIONS				
BCuP-1	Cu 95, P 5	1305	1650	1450-1700	Suited particularly for resistance brazing
BCuP-2	Cu 93, P 7	1305	1485	1350-1550	Extremely fluid at brazing temperature
BCuP-3	Cu 89, Ag 5, P 6	1195	1500	1300-1550	Extremely fluid at brazing temperature
BCuP-4	Cu 87, Ag 6, P 7	1185	1380	1300-1500	Best suited for joint clearances of 0.001 to 0.003 in.
BCuP-5	Cu 85, Ag 15, P 5	1185	1500	1300-1500	Particularly adaptable where close fits cannot be held
BAg	SILVER CLASSIFICATIONS				
BAg-1	Ag 45, Cu 15, Zn 16, Cd 24	1125	1145	1145-1400	General purpose, color light yellow after brazing
BAg-1a	Ag 50, Cu 15.5, Zn 16.5, Cd 18	1160	1175	1175-1400	General purpose, color light yellow after brazing
BAg-2	Ag 35, Cu 26, Zn 21, Cd 18	1125	1295	1295-1500	General purpose, color yellow after brazing
BAg-3	Ag 50, Cu 15.5, Zn 15.5, Cd 16, Ni 3	1195	1270	1270-1500	Widely used for joining carbide tools to tool shanks
BAg-4	Ag 40, Cu 30, Zn 28, Ni 2	1240	1435	1435-1650	Widely used for joining carbide tools to tool shanks
BAg-5	Ag 45, Cu 30, Zn 25	1250	1370	1370-1550	General purpose, color light yellow after brazing
BAg-6	Ag 50, Cu 34, Zn 16	1270	1425	1425-1600	General purpose, color light yellow after brazing
BAg-7	Ag 56, Cu 22, Zn 17, Sn 5	1145	1205	1205-1400	General purpose for cadmium-free joint
BAg-8	Ag 72, Cu 28	1435	1435	1435-1650	For joints where volatile elements are prohibited as in vacuum tubes
BAg-9	Ag 65, Cu 20, Zn 15	1280	1325	1325-1550	Particularly for joining sterling silver, color white after brazing
BAg-10	Ag 70, Cu 20, Zn 10	1335	1390	1390-1600	Particularly for joining sterling silver, color white after brazing
BAg-11	Ag 75, Cu 22, Zn 3	1365	1450	1450-1650	Particularly for joining sterling silver, color white after brazing
BCuAu	COPPER-GOLD CLASSIFICATION				
BCuAu-1	Au 37.5, Cu 62.5	1755	1815	1815-2000	For joining parts in electronic tube assemblies
BCuAu-2	Au 80, Cu 20	1620	1630	1630-1850	For joining parts in electronic tube assemblies
BCu and BCuZn	COPPER-ZINC CLASSIFICATION				
BCu	Cu 99	1980	1980	2000-2100	For joining ferrous metals, nickel and nickel-copper alloys
BCuZn-1	Cu 60, Zn 40	1650	1660	1670-1750	For joining steels, copper, copper alloys, nickel, nickel alloys, stainless steel
BCuZn-2	Cu 57, Zn 42, Sn 1	1630	1650	1670-1750	For joining steels, copper, copper alloys, nickel, nickel alloys, stainless steel
BCuZn-3	Cu 56, Zn 40, Sn 1, Fe 1, Mn 1, Ni 1	1590	1630	1670-1750	For joining steels, copper, copper alloys, nickel, nickel alloys, stainless steel
BCuZn-4	Cu 52.5, Zn 47.5	1517	1595	1600-1700	For joining steels, copper, copper alloys, nickel, nickel alloys, stainless steel
BCuZn-5	Cu 51.5, Zn 45, Sn 3.5	1585	1610	1620-1700	For joining steels, copper, copper alloys, nickel, nickel alloys, stainless steel
BCuZn-6	Cu 48, Zn 42, Ni 10	1690	1715	1720-1800	For joining steels, nickel and nickel alloys
BCuZn-7	Cu 47, Zn 41.5, Ni 10.5, Ag 1	1685	1710	1690-1800	For joining steels, nickel and nickel alloys
BMg	MAGNESIUM CLASSIFICATION				
BMg	Mg 89, Al 9, Zn 2	770	1110	1120-1160	For joining M1 magnesium
BNiCr and BAgMn	HEAT-RESISTANT CLASSIFICATION				
BNiCr	Ni 70, Cr 16.5, Fe+Si+C 10	1850	1950	2000-2150	For joining stainless steels and high nickel alloys for use at elevated temperatures
BAgMn	Ag 85, Mn 15	1760	1780	1780-2100	For joining stainless steels and high nickel alloys for use at 500-900 F

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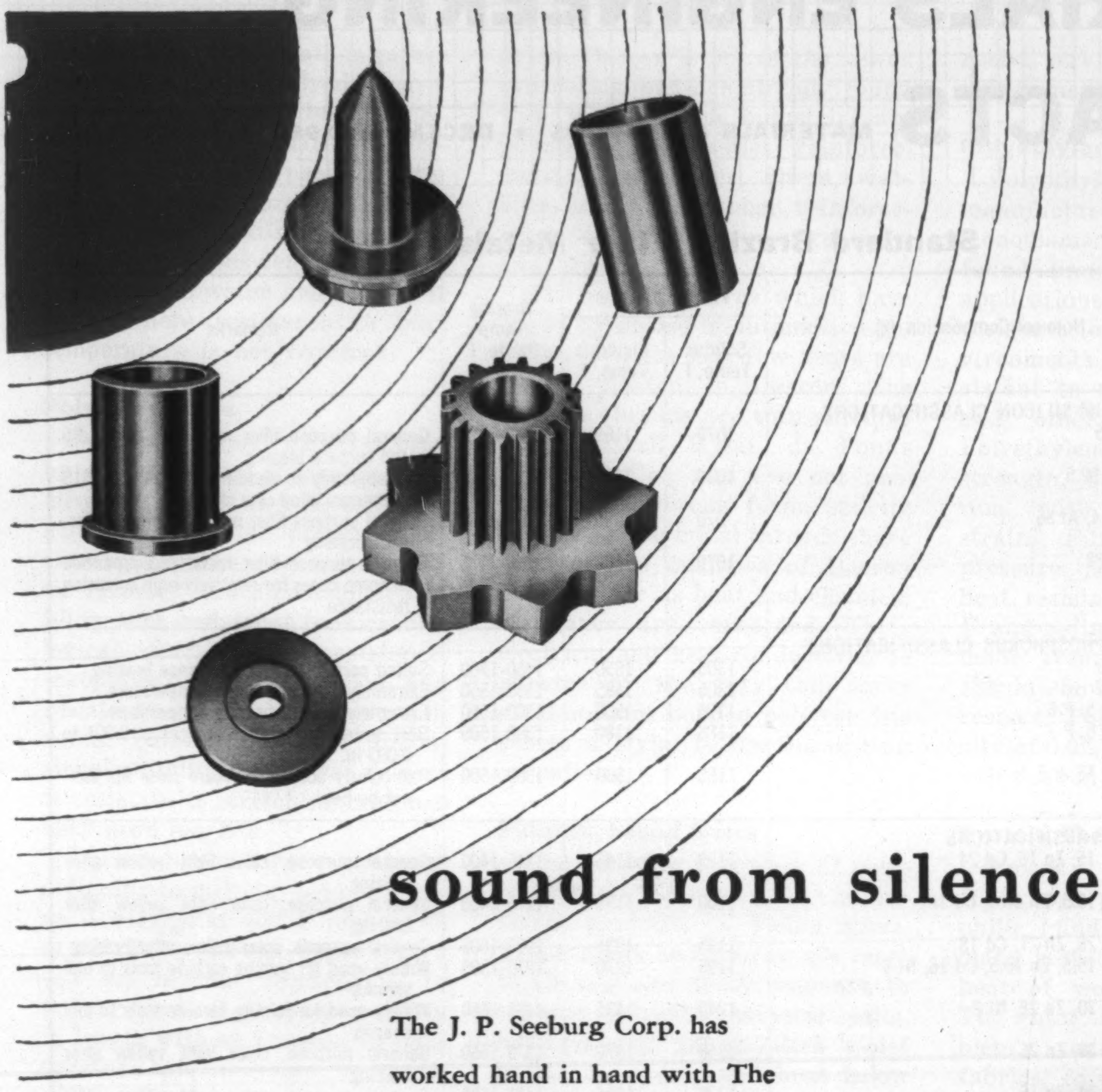
(continued on page 139)



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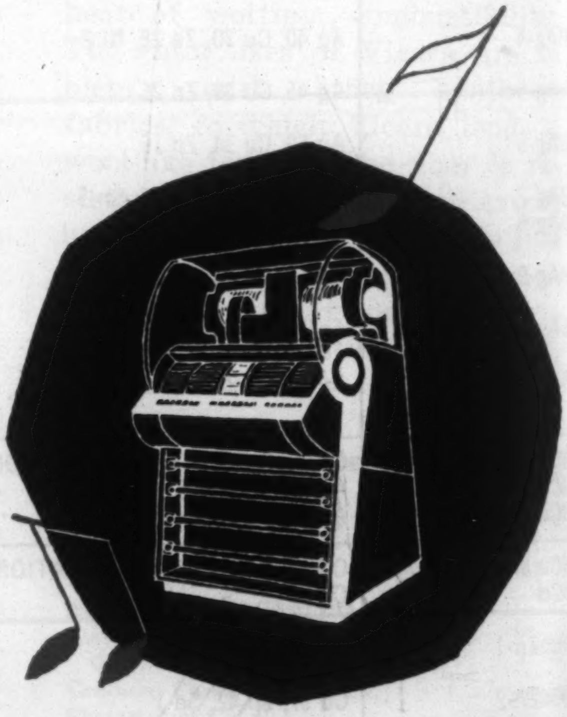

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Standard Brazing Filler Metals (cont.)

AWS-ASTM Classification	Standard Form	Size, in.
ALUMINUM-SILICON:		
BAlSi-1 and BAlSi-3	Strip	0.020 by 2
	Wire in coils	Round, 1/16—3/16
	Rod	Round, 1/16—¼ by 18—36
BAlSi-2	Coated sheet	0.006—¼ [a]
	Strip	0.020 by 2
BAlSi-4	Wire in coils	Round, 1/16—3/16
COPPER-PHOSPHORUS:		
BCuP-1	Strip	0.005—0.015 by 1½
BCuP-2	Wire in coils	Round, 1/16—3/16 Square, ⅛—3/16
	Rod	Round, 1/16—¼ by 18—36 Square, ⅛—¼ by 18—36
	Powder	50—325 mesh
BCuP-3	Wire in coils	Round, 0.047—⅛
	Rod	Round, 1/16—¼ by 18—36
	Powder	50—325 mesh
BCuP-4	Wire in coils	Round, 0.047—3/16 Square, ⅛—¼
	Rod	Round, 1/16—¼ by 18—36 Square, ⅛—¼ by 18—36
	Powder	50—325 mesh
BCuP-5	Strip	0.003—0.025
	Wire in coils	Round, 0.010—¼ Square, ⅛—¼
	Rod	Round, 1/32—¼ by 18—36 Square, ⅛—¼ by 18—36
	Powder	50—325 mesh
SILVER:		
All Classifications	Strip	0.003—0.025
	Wire in coils	Round, 0.010—3/16 Square, ⅛—3/16
	Rod	Round, 1/16—¼ by 18—36 Square, ⅛—¼ by 18—36
	Powder	50—325 mesh
COPPER-GOLD:		
BCuAu-1 and BCuAu-2	Strip	To order
	Wire in coils	To order
COPPPER AND COPPER-ZINC:		
BCu, BCuZn-1, BCuZn-2, and BCuZn-3	Strip	0.004—0.025
	Wire in coils	Round, 0.003—¼
	Rod	Round, 1/16—⅜
BCuZn-4	Grain	3—40 mesh
BCuZn-5	Grain	3—70 mesh
BCuZn-6	Strip	0.006—0.025
	Wire in coils	Round, 1/16—¼
	Rod	Round, 1/32—¼ by 18—36
BCuZn-7	Strip	0.006—0.025
	Wire in coils	Round, 1/16—¼
	Rod	Round, 1/16—¼ by 18—36
	Powder	40—180 mesh
MAGNESIUM:		
BMg	Wire in coils	Round, 3/64—3/16
	Rod	Round, 3/64—3/16 by 18—36
HEAT-RESISTING MATERIALS:		
BNiCr	Strip	0.005—0.020
	Wire in coils	Round, 1/16—⅛
	Powder	325 mesh
BAgMn	Strip	0.003—0.025
	Wire in coils	Round, 0.010—¼
	Rod	Round, 1/16—¼ by 18—36

[a] *Coated on one or both sides: coating varies from 5 to 10 per cent of the thickness of the base metal sheet: several aluminum-alloy base metals are available.*

Adapted from Brazing Manual, American Welding Society, published by Reinhold Publishing Corp. 1955

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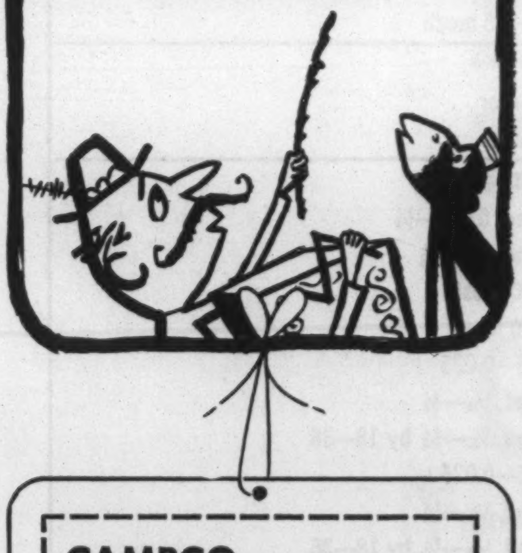

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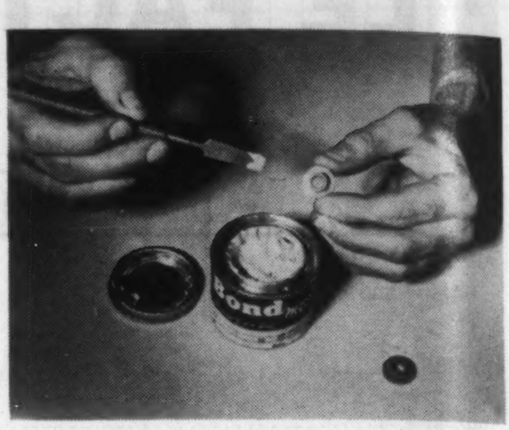
New Epoxy Adhesive



A one-component formulation ▸

that is thixotropic ▸

by Bernard Gould, *Manager, Market Development, Rubber and Asbestos Corp.*

■ An epoxy-based paste adhesive that can be used directly from the container has now been developed. By eliminating the need for mixing of a separate resin and hardener (catalyst), this new formulation should make more economical adhesive metal bonding as well as the bonding of other rigid materials. The new adhesive is also thixotropic, which means complete absence of drip or flow either before or during cure.

The new adhesive, named Bondmaster M620, is a 100% solids epoxy-based material and is a variation of the one-part powder form known as Bondmaster M640 (formerly Araldite AN-100). This formulation has been made possible by the recent introduction of stable, compatible thixotropic agents, and the addition of hardener systems which combine a practical curing cycle with excellent storage stability in the presence of the reactive liquid epoxy resin. The new paste formulation overcomes the difficulties of working with a powder in production applications, while retaining all the advantages of a one-component system.

Besides the cost and time savings realized through the elimination of measuring, weighing and mixing operations, the new adhesive costs less than one-half that of conventional 100% solids two-component formulations. The physical and mechanical properties at room temperature are comparable to or better than the older two-component materials. For example, the tensile shear strength, using a curing cycle of 325 F for 1 hr, is 2800 psi at room temperature and 1600 psi at 260 F.

The new epoxy adhesive has a smooth, buttery consistency and is easily spread with brush or spatula. It also allows a wide choice of curing cycles as indicated below.

Temp in the Bonding Layer, F	Min Curing Time
535	7 to 10 min
500	12 to 15 min
450	20 to 25 min
400	40 to 50 min
350	1½ to 2 hr
300	4 to 5 hr
260	20 to 24 hr

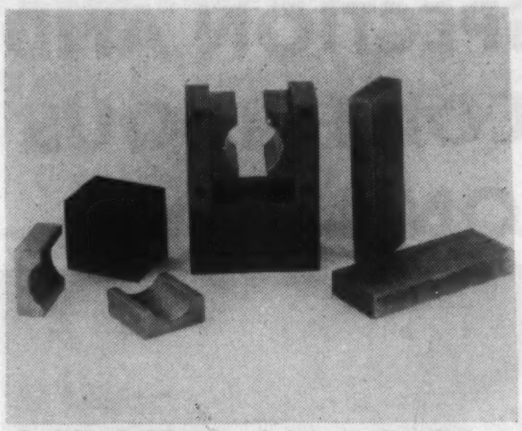
(Continued on p. 142)

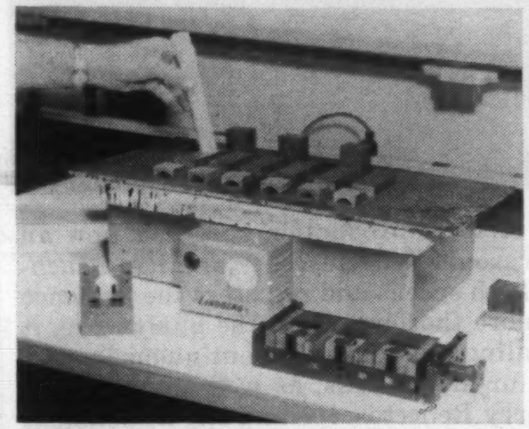
Where The New Adhesive Is Being Used

Bonding metals

At Bristol Co. the new epoxy formulation is being used to bond small parts in a millivoltmeter pyrometer movement. They found the one-part adhesive in powder form to be impractical when working with small parts. So they tried the new paste adhesive which they molded into rod for even greater ease of application.

Adhesive bonding proved best for this application because the magnetic iron powder parts (large cubical blocks) are difficult to machine for a screw fastening. The usual practice is to core holes in the iron powder part for a through-bolt connection. Use of the new adhesive simplifies the design and provides permanent alignment of the component parts.


Cubical block *(left) is bonded to other small parts of pyrometer movement.*

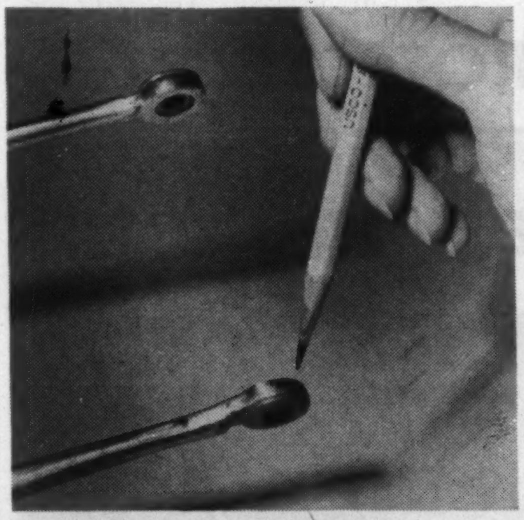

Adhesive *in rod form being applied.*

Bonding ceramics to metal

Dolphin Jute Mills is successfully using the one-component epoxy adhesive to bond abrasion resistant, chemically inert industrial ceramic inserts to metal parts.

In one part, ceramic rings are bonded to steel spinning flyer eyes; in another part, a ceramic ball is bonded to a cast aluminum winding traverse guide. The long wearing ceramic had been developed to replace carbide, but its general acceptance was delayed because of the difficulty of obtaining a sufficiently strong ceramic-to-metal joint.

Joints with the one-part epoxy adhesive have proved more than adequate in strength. In addition, the thixotropic nature of the material makes it possible to accurately predetermine the thickness of the joint and thus maintain the necessary tolerance. The non-flow characteristic also eliminates post-cleaning operations.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Ultrasonic News

Sperry

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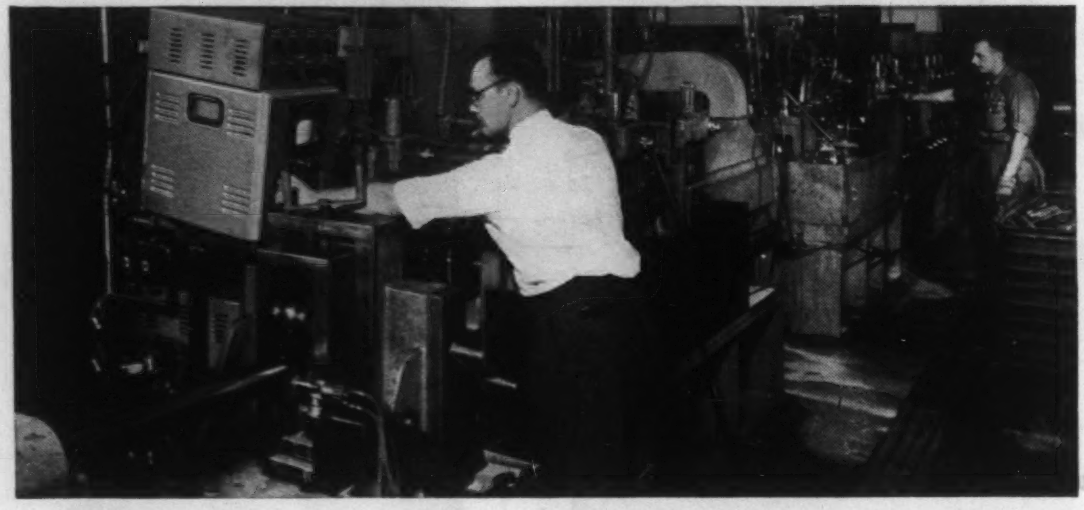

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ELECTRONIC PROTECTRON SENSES OVERLOADS— MINIMIZES PRESS DAMAGE

A punch press attachment, which detects the slightest overloads caused by pile-ups, misfeeds, tool dullness, misalignment, the Sperry Protectron® minimizes tool and die damage by warning signals and actuation of control devices. The Protectron also cuts costly equipment damage and keeps all automatic machines running without close attention. With Protectron on guard, one man can safely and easily operate several machines at once.

Sperry offers America's most complete line of ultrasonic testing equipment for practical industrial applications.

Sperry Products, Inc.
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☐ Please send me complete information on Sperry Ultrasonic Testing.

Materials to be tested________

☐ Please send me complete information on the Sperry Protectron.

☐ Have your representative call.

Name________

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Company________

Address________

City________Zone________

State________

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Continued from p. 141

Other characteristics of the new product are listed below:

Color—light tan, opaque
Odor—none after curing
Clean-up solvent—Ketone before curing
Weight—approx 9½ lb per gal
Storage—good for six months

It's thixotropic

In many applications the thixotropic property of the new adhesive formulation is considered its most important advantage. The thixotropic nature of the material results in a complete absence of movement either before or during cure. The thickness of the glue line laid down by the user before curing, whether 0.001 in. or ½ in., remains the finished glue line thickness after curing. Because there is no flow during the curing cycle, the adhesive may be applied in a vertical position and the part jigged at right angles or any acute angle, with the finished bond retaining the assembly in that exact position.

An added advantage of a thixotropic material of this type is that it can be used for "poor fit joints" and similar void-filling applications as well as where unsightly dripping or running of adhesive must be controlled.

now even better
invest more in
Defense Bonds

New Materials, Parts and Finishes | and related equipment

Colored Anodized Aluminum Stock Cuts Production and Finishing Costs

Dyed, anodized aluminum is being produced continuously in a range of alloys by several companies in the form of sheet and strip. Colored tubing and extruded shapes are available in stock lengths. Though the dyeing of the film formed on aluminum by anodic oxidation has been common practice for many manufacturers, it has been limited to coloring the finished part or component after forming. Availability of colored aluminum stock which can be subsequently blanked and formed promises substantial economies both in mechanization of production and reduction of finishing costs. An additional advantage lies in the fact that the color is integral with the material, thus there is no variation in gage or dimensions as there may be with overlying film.

How it is colored

The oxide film formed by anodizing is hard and minutely porous. This porosity permits the coloring medium to enter into and become part of the oxide coating itself. Though the current trend in color anodizing is toward use of lightfast organic dyes, there are several other methods in use. As well as organic dyes, inorganic materials can be used. Or colored films can be produced directly from the electrolyte in the anodizing bath by using the proper acid combinations and addition agents.

Coloring with organic dyes simply involves immersion in a dye bath maintained at about 170 F. Anthracene blue and alizarin red S are typical of a large number of acid dyes which may be used to obtain various colors. Use of inorganic materials involves treating the material with solutions which react with one another to form insoluble color compounds. For example, nickel acetate treated with ammonium sulfide will produce black colored films, or zinc acetate treated with potassium dichromate will produce yellow films. Potassium ferrocyanide treated with ferric chloride will produce blue films.

Colored oxide films can also be produced directly in the anodizing bath by acid combinations and addition agents. For instance, chromic and oxalic acids produce varying shades of browns, or sulfanic acid and sodium borate produce silvery oxide films. Time, temperature, current density, voltage, electrolyte used, as well as the alloy treated have a direct bearing on the resulting color.

After treating the film, pores in the surface must be sealed. This can be done by immersion in hot water which converts aluminum oxide to the monohydrate with a consequent increase in volume which effectively seals the pores. Or they may be sealed by treatment in a solution of sodium chromate or dichromate. Chromate is absorbed in the coating and effectively adds to its protective value. Solutions of nickel or cobalt acetate are also used to seal porous films, especially after treatment with organic dyes. These materials tend to set the dye and seal pores at the same time.

A variety of colors is available, ranging from blue, green, yellow, gold, grey and black to shades and combinations of these colors. The colors are said to have generally good durability, their resistance to weathering and light being a function of the coloring material used and the thickness of the anodic coating.

Formability

Since anodic coatings are relatively hard and brittle, one of the major problems in developing pre-colored aluminum has been in obtaining an anodic film which is ductile enough to permit forming. Since the material is so new, definitive formability data are not yet available. Most companies state that shallow draws are feasible. Draw depths measuring one-half the diameter of the cup have been formed successfully with conventional tooling. Interesting possibilities would seem to exist with forming methods using flexible male or female die members. Another source says that reduction possible with the materials ranges from 25 to 30%.

For minimum bend radii, 5 to 7 times the thickness have been used successfully and some companies recommend a 3t minimum.

(Continued on p. 146)

None of these figures should be taken as limiting. They are given only to indicate possibilities of the materials. Formability for specific applications, of course, will depend on alloy, temper, thickness and specific design, as well as the ductility of the particular oxide coating.

Colored anodized aluminum is particularly well suited to roll forming, as radii can usually be generous, precluding danger of crazing of the film. Also, since strip and sheet materials are color anodized in continuous lengths, they can be mechanically fed to roll forming machines from coils.

Coiled strip

Continuously anodized and dyed aluminum strip in 1100 alloy and purer, is being imported and distributed under the trade name Ano-Coil by *Fromson Orban Co., Inc.*, 261 Madison Ave., New York 16. It is available in commercial coils in thicknesses from 0.003 to 0.020 in. and widths from ¾ to 20 in. Thicknesses of 0.003 to 0.008 in. are available in widths of 8 in. or wider only. A variety of colors is available. Gold and brass tones are obtained with inorganic dyes which are lightstable. All other colors are based on organic dyes which are suitable for most indoor use, but are not recommended for outdoor use. It is available with bright, mill, matte and brushed finishes, though the bright or mirror finish is limited to gages between 0.003 to 0.014 except in 99.99% aluminum. The materials are available in all commercial tempers.

Sheet and strip

Colored sheet and strip in a apparent fading of colors. It is produced continuously by *Aluma Kraft Mfg. Co.*, 1330 N. Rock Hill Rd., St. Louis, Mo. According to the producer, the finish is opaque, similar to an enamel or lacquer finish, rather than translucent. The material is being produced in alloys 1100, 5005, 5050, and 5052, in gages up to 0.064 and widths up to 48 in. The company is the sole licensee of the so-called Spectromatic Process. According to the company, in a Weatherometer test, samples are constantly exposed to cycles of 17 min of ultraviolet light and 3 min of salt spray. After 2647 hr of continuous exposure, there has been no apparent fading of colors. It is recommended for use both indoors and out.

Sheet, tubing and extrusions

Various colors, and shade variations of each, can now be ordered on sheet, extruded shapes, rod, bar and on drawn and extruded tube from *Aluminum Co. of America*, 1501 Alcoa Bldg., Pittsburgh 19. Drawn and extruded tubes and shapes are being produced in 30-ft maximum lengths, and flat sheet is produced in widths up to 84 in. and lengths up to 32 in. in all sheet thicknesses subject to commercial rolling limitations.

Coiled sheet and strip is available in continuous lengths, in widths up to 24 in. and thicknesses of 0.006 to 0.051 in.

Two general classes of color anodized products are available: decorative color finish and architectural color finish. The former is designed for both interior and exterior application. The architectural finishes are designed primarily for hard-weathering exterior service. Both general classes, called Alumilite, are supplied on all extruded forms and on flat sheet including coined sheet. Decorative finishes are also supplied in continuous coiled sheet.

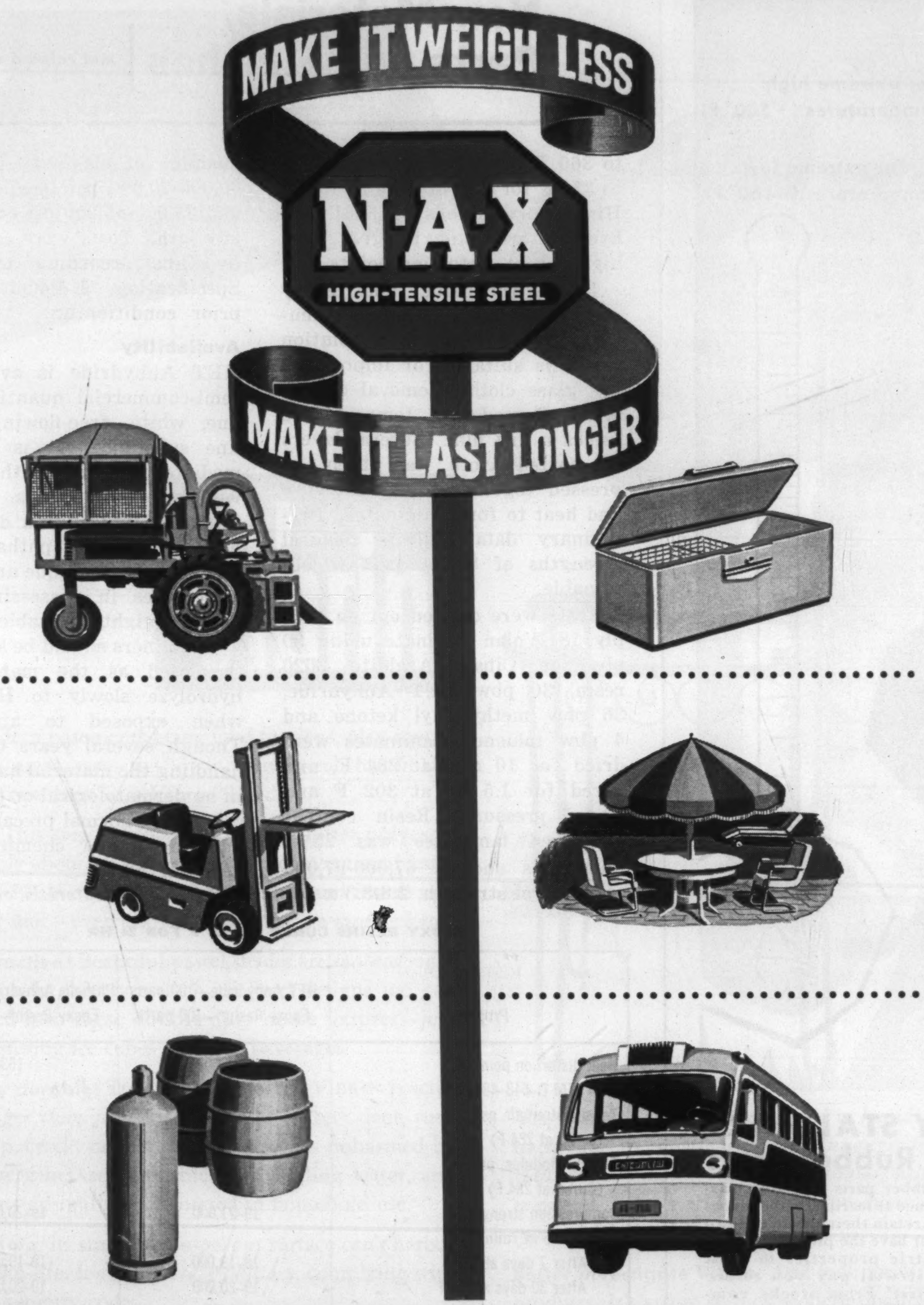
As well as being supplied in various colors, different types of decorative finishes are available based on resistance to weathering, resistance to wear and formability. Each of these, in turn can be supplied either with no surface preparation, an etch which produces a matte finish, or a brightening treatment. Decorative color finishes on tubing and extruded shapes have an additional range of surface preparations possible.

New Hardener for Epoxies

A new chemical, when used as a curing agent for liquid epoxy resins, is said to provide the cured plastics with fire resistance and heat distortion values up to 375 F. It has good electrical characteristics, which it retains at high operating temperatures, and no dermatological effects have been observed during its use. Developed by *Hooker Electrochemical Co.*, Box 344, Niagara Falls, N. Y., the material is sold under the trade name HET Anhydride, and is formed by the reaction of hexachlorocyclopentadiene and maleic anhydride. It can be used with laminating or casting resins and is recommended for use in approximately equal proportions with epoxy resins. Since HET Anhydride costs about $.55 per lb, this larger than usual proportion of hardener reduces the amount of epoxy necessary, and thus reduces over-all costs.

Properties of cured resins

The accompanying table lists for comparison typical physical properties of epoxy resins cured with HET Anhydride and phthalic anhydride. Heat distortion points for resin mixes vary with curing temperatures and length of cure. They range from a low of 203 F for a 2-hr cure at 250 F,



You can design light weight, longer life, and economy into your products by including N-A-X HIGH-TENSILE in your plans.

- It is 50% stronger than mild steel.
- It is considerably more resistant to corrosion.
- It has greater paint adhesion with less undercoat corrosion.
- It has high fatigue life with great toughness.
- It has greater resistance to abrasion or wear.
- It is readily and easily welded by any process.
- It polishes to a high lustre at minimum cost.

And with all these physical advantages over mild carbon steel—it can be cold formed as readily into the most difficult shaped stamping.

When you next start to redesign, get the facts on N-A-X HIGH-TENSILE. It's produced by Great Lakes Steel—long recognized specialists in flat-rolled steel products.

N-A-X Alloy Division

GREAT LAKES STEEL CORPORATION

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New Materials, Parts and Finishes

and related equipment

to 360 F for 6-hr cure at 360 F, to 370 F for a 24-hr cure at 360 F. Higher proportions of HET Anhydride are said to give even higher heat distortion points.

HET Anhydride and epoxy resins can be dissolved in a mutual solvent to form a solution which is suitable for impregnating glass cloth. Removal of solvent at moderate temperatures leaves a dry film. Several layers of coated cloth can then be pressed together under pressure and heat to form laminates. Preliminary data indicate flexural strengths of 80,000 psi are obtainable.

Tests were carried out on a 12 ply 181-Volan laminate using 30 pbw of Ciba's Araldite 6020 resin, 30 pbw HET Anhydride, 36 pbw methylethyl ketone and 4 pbw toluene. Laminates were dried for 10 min at 284 F, and cured for 1.5 hr at 302 F and 30-psi pressure. Resin content of cured laminates was 25%. Laminates showed 67,000-97,000 psi flexural strength, 2.8-3.3 x 10^6 modulus of elasticity in flexure, 60,000-70,000 psi tensile strength and 35,000-45,000 psi compressive strength. Tests were carried out by Ciba according to Federal Specification L-P406b without prior conditioning.

Availability

HET Anhydride is available in semi-commercial quantities, as a fine, white, free-flowing crystalline substance. It is an intermediate for the synthesis of a variety of compounds. Its reactions are typical of a dibasic anhydride such as phthalic anhydride, yet it is unique among such anhydrides in possessing 57.4% of its weight in stable chlorine.

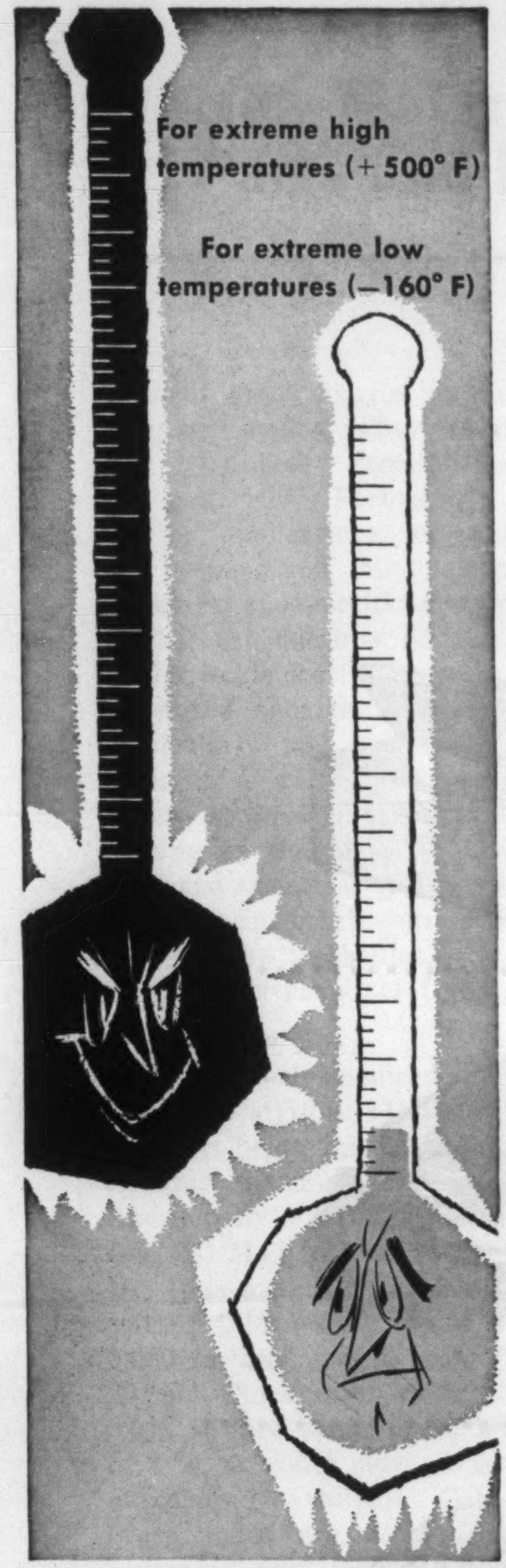
Containers should be kept tightly closed as the material will hydrolyze slowly to HET Acid when exposed to atmosphere. Though several years experience handling the material has resulted in no dermatological or toxicological effects, normal precautions for handling a new chemical should be observed.

(More New Materials on p. 150)

EPOXY RESINS CURED AT 250 F FOR 24 HR

Property	HET Anhydride—100 parts Epoxy Resin*—100 parts	Phthalic Anhydride—40 parts Epoxy Resin*—100 parts
Heat distortion point, F (ASTM D-648-48T)	290–300	153
Tensile strength, psi (cured at 284 F)	12,000	—
Tensile modulus, psi (Cured at 284 F)	4.5 x 10^5	—
Compression strength (psi 0.05 in./min)	19–21,000	19–20,000
After 7 days at 392 F	18–19,000	18–19,000
After 30 days at 392 F	19–20,000	19–20,000
Barcol hardness	46–50	35
Burning rate		
(ASTM D-757-49), in./min	0.15	1.17
(ASTM D-635-44)	self-extinguishing	flammable
Density	1.43	1.25
Shrinkage during cure, % vol	1.3	2.3
Weight loss		
7 days at 392 F, %	0.7	1.5
30 days at 392 F, %	4.0	2.7
Pot life of resin at 248 F, hr	½	6

*Epoxide equivalent of 210.

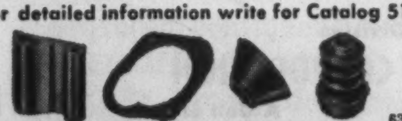


For extreme high temperatures (+ 500° F)
For extreme low temperatures (−160° F)

SPECIFY STALWART Silicone Rubber Parts

For Silicone rubber parts that give maximum performance at searing temperatures up to +500° F... retain their elasticity down to −160° F... or have the physical, chemical and dielectric properties to resist chemicals... it will pay you to see STALWART first! From stocks compounded for specific job requirements, STALWART will mold, extrude, die-cut, lathe-cut, or mandrel-build parts to meet individual, S. A. E. or A. S. T. M. specifications. Bring your rubber problems to STALWART... specialists in the custom-fabrication of precision Silicone parts.

For detailed information write for Catalog 51SR-1



6307-SR

STALWART RUBBER CO.

Mfg. Plants in Bedford, Ohio and Jasper, Georgia
Main Offices 165 Northfield Road, Bedford, Ohio

For more information, Circle No. 500

Look what's happened to laundry tubs!...

Vibrin

With modern basements being used for dens, play rooms, and party areas, even the lowly laundry tub has finally gotten a "new look"... a *Vibrin* "look"!

Lighter! This new tub of reinforced VIBRIN polyester weighs only about *1/10th as much* as conventional laundry tubs—is easier and less costly to ship and install as a stationary unit—even allows mounting on a *mobile base!*

More attractive! Beautiful pastel shades are *molded right in*... can't fade, chip, or scratch off. Party designs, too, can be molded into these double-duty home fixtures—just right for storing ice cubes and cold beverages.

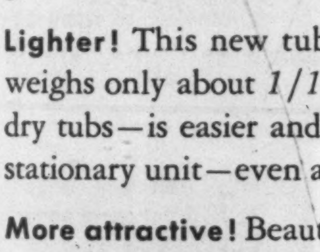
Extremely durable! The tough reinforced VIBRIN is actually *stronger than steel* for its weight—won't dent, rust, chip, warp, crack, or craze! Of course, it's unharmed by soaps, detergents, starches, bleaches, boiling water, and such agents normally encountered in household use.

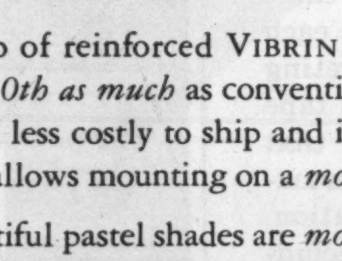
What's more, its smooth *non-porous* surface can't harbor dirt or germ-life. It's *completely sanitary,* complying with the latest sanitary codes.

Yes, the same thing has happened to *laundry tubs* that has happened to *sport-car bodies, luggage, furniture, bath tubs, pipe, paneling, aircraft radomes, fishing rods, and many* of today's truly modern products. They've been *made* modern with VIBRIN.

Better investigate Vibrin. And look for VIBRIN in *other* products. It's a sure sign of modern quality.

Laundry tubs of Naugatuck VIBRIN® by Gray-Wilson Corp., Detroit, Mich., molded by Waterbury Companies, Waterbury, Conn. and Camfield Fiber Glass Plastics, Inc., Grand Haven, Mich.





Naugatuck Chemical

Division of United States Rubber Company
Naugatuck, Connecticut

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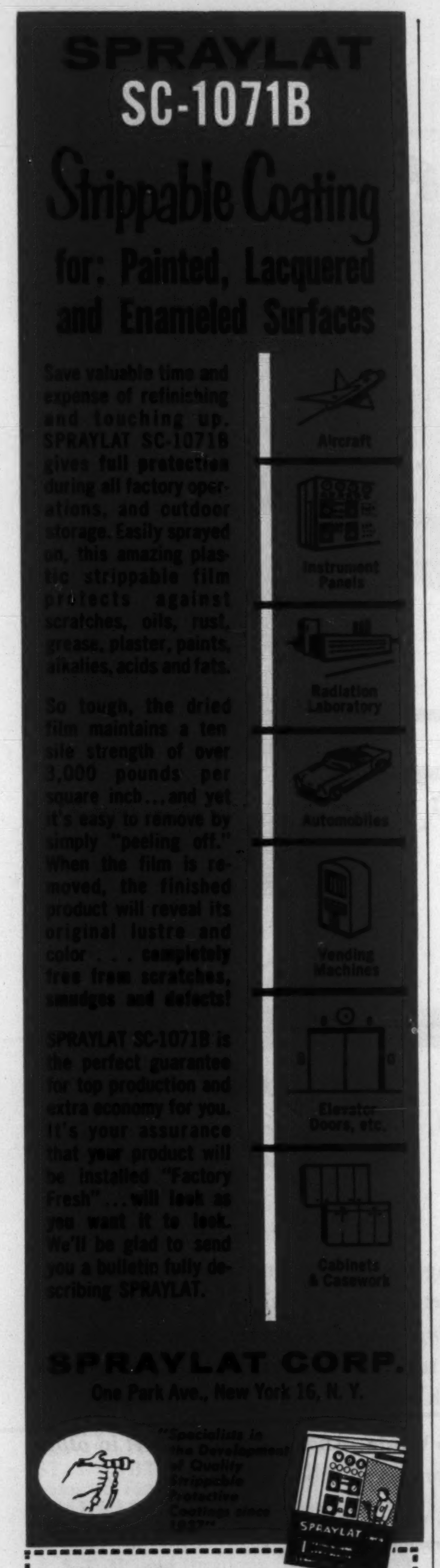

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SC-1071B
Strippable Coating
for: Painted, Lacquered and Enameled Surfaces

Save valuable time and expense of refinishing and touching up. SPRAYLAT SC-1071B gives full protection during all factory operations, and outdoor storage. Easily sprayed on, this amazing plastic strippable film protects against scratches, oils, rust, grease, plaster, paints, alkalies, acids and fats.

So tough, the dried film maintains a tensile strength of over 3,000 pounds per square inch . . . and yet it's easy to remove by simply "peeling off." When the film is removed, the finished product will reveal its original lustre and color . . . completely free from scratches, smudges and defects!

SPRAYLAT SC-1071B is the perfect guarantee for top production and extra economy for you. It's your assurance that your product will be installed "Factory Fresh" . . . will look as you want it to look. We'll be glad to send you a bulletin fully describing SPRAYLAT.

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firm name____________________
city__________zone____state______

For more information, Circle No. 458

New Materials, Parts, Finishes

Four New Tapes

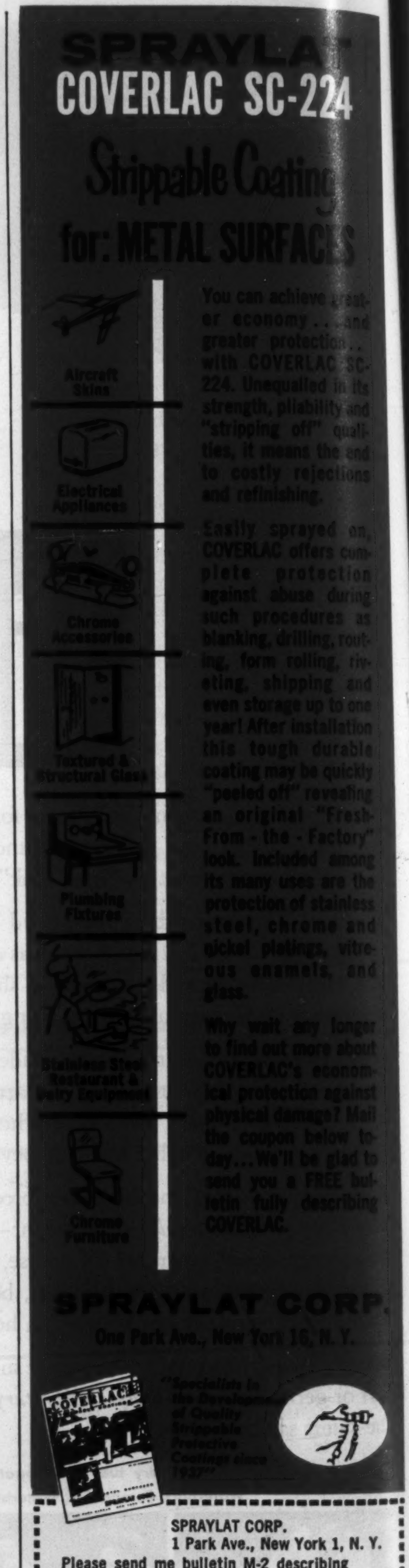
Four new tapes have been marketed recently: a polyethylene base electrical tape, a cloth friction tape, a cotton cloth tape for ductwork sealing, and a tack cloth for removing foreign particles during machining and production operations.

Polyethylene-base tape

A polyethylene-base tape called Bi-Seal Type 2 Electrical Tape has been marketed to serve as primary insulation for permanent, water-tight sealing of conductor joints in cathodic protection cable. Developed by *Bishop Mfg. Corp.*, 112 Factory St., Cedar Grove, N. J., the tape is said to assure electrical and mechanical protection of cathodic-protection cable joints. It is applied to a specified thickness over the joint and is extended along the cable jacket for at least 2 in. at each end of the conductor. A jacketing tape applied over the Bi-Seal tape is said to complete a splice that meets requirements for permanent underground installation. The tape is self-bonding precluding possibilities of the layers unwrapping. It is also fungus-proof and withstands attack of soil bacteria.

Black cloth friction tape

A black production grade cloth tape designed to replace friction tape has been marketed by *Permacel Tape Corp.*, New Brunswick, N. J. Designated Permacel 64, the tape is said to stick better to its own backing and application surfaces than friction tape and retains its adhesion qualities over periods of storage. It is said to average twice the insulation resistance of friction tape, yet is thinner, building up less bulk in multiple wraps. Adhesive is applied to only one side of the tape, eliminating messy pick-up of lint and dust. It is said to be particularly useful for bundling assemblies of loose parts; binding coils of wire, cables and piping; pro-



SPRAYLAT
COVERLAC SC-224
Strippable Coating
for: METAL SURFACES

You can achieve greater economy . . . and greater protection . . . with COVERLAC SC-224. Unequalled in its strength, pliability and "stripping off" qualities, it means the end to costly rejections and refinishing.

Easily sprayed on, COVERLAC offers complete protection against abuse during such procedures as blanking, drilling, routing, form rolling, riveting, shipping and even storage up to one year! After installation this tough durable coating may be quickly "peeled off" revealing an original "Fresh-From-the-Factory" look. Included among its many uses are the protection of stainless steel, chrome and nickel platings, vitreous enamels, and glass.

Why wait any longer to find out more about COVERLAC's economical protection against physical damage? Mail the coupon below today . . . We'll be glad to send you a FREE bulletin fully describing COVERLAC.

Aircraft Skins
Electrical Appliances
Chrome Accessories
Textured & Structural Glass
Plumbing Fixtures
Stainless Steel Restaurant & Dairy Equipment
Chrome Furniture

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"Specialists in the Development of Quality Strippable Protective Coatings since 1937"

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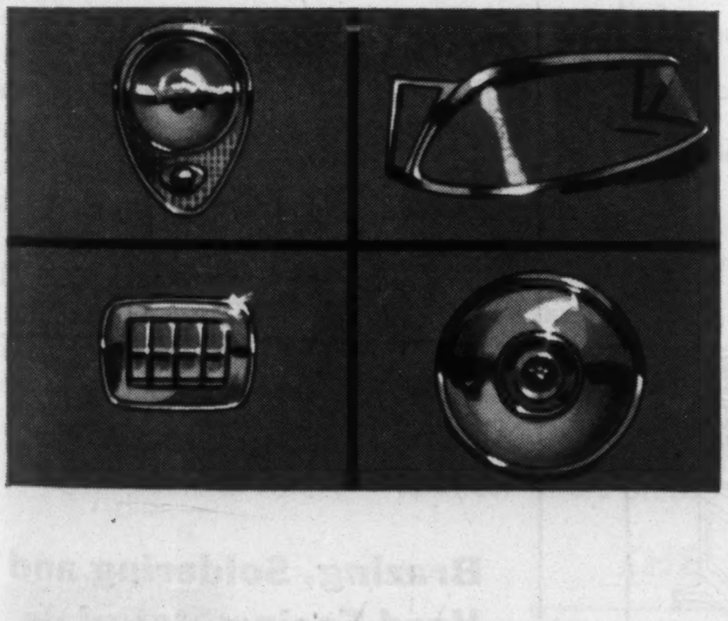
modern design specifies stainless steel

McLouth
STAINLESS
Steel
for automobiles



The beautiful bright molding and trim that style your car are made of non-corrosive, easy to clean Stainless Steel. Designers of automobiles and hundreds of other products specify Stainless Steel for its many valuable properties.

For the product you make today and the product you plan for tomorrow specify McLouth high quality sheet and strip Stainless Steel.

McLOUTH STEEL CORPORATION
Detroit, Michigan

MANUFACTURERS OF STAINLESS AND CARBON STEELS

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ACCO products

Wilson "Rockwell"* Hardness Testers

EASY TO USE
as a scale

SENSITIVE & ACCURATE
as a precision balance

DURABLE
as a
machine tool

3-JR MODEL
Invaluable for tool room use
and most production testing

Fully Automatic

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Superficial

Tukon Micro and Macro Hardness Testers

● WILSON "Rockwell" Hardness Testers were the first to combine in one high grade instrument the precision and sensitivity demanded in the metallurgical laboratory, the accuracy required in the tool room *plus* the ease of operation and durability for daily use on the production line.

Now the world's standard of accurate hardness tests since 1921, WILSON "Rockwell" Hardness Testers have developed to keep pace with the ever-expanding requirements of industry. Their testing scope and capacity has increased until their use in steel mills, non-ferrous mills and metal fabricating plants is universal.

A staff of WILSON hardness-testing experts is conveniently located to check your needs with you—recommend just the size and model best suited to the job. Why not call or write today?

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ACCO Wilson Mechanical Instrument Division
AMERICAN CHAIN & CABLE
230-E Park Avenue, New York 17, N. Y.

for Better Value

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tecting finished metal surfaces from abrasion; protecting threaded ends of pipe and threaded openings; and sealing bags, cartons, cans, canisters and other shipping containers.

Cotton cloth tape

A silver cotton cloth tape, Permacel 691, has been marketed primarily for sealing of ductwork in heating, ventilating and exhausting systems, holding building insulating materials and bundling sheet metals. Made of plastic-coated cotton cloth backing, it is 0.014 in. thick, with a tensile strength of 55 lb per in. width and tear strength of 500 gm. It has good resistance to water and moisture, providing an effective seal against air leaks as well as dust. Designed and certified to meet Federal Spec PPP-T-0060 and JAN-P-127, the material is said to stick and conform to shapes well at low temperatures. It is a product of *The Permacel Tape Corp.*, New Brunswick, N. J.

Tack cloth

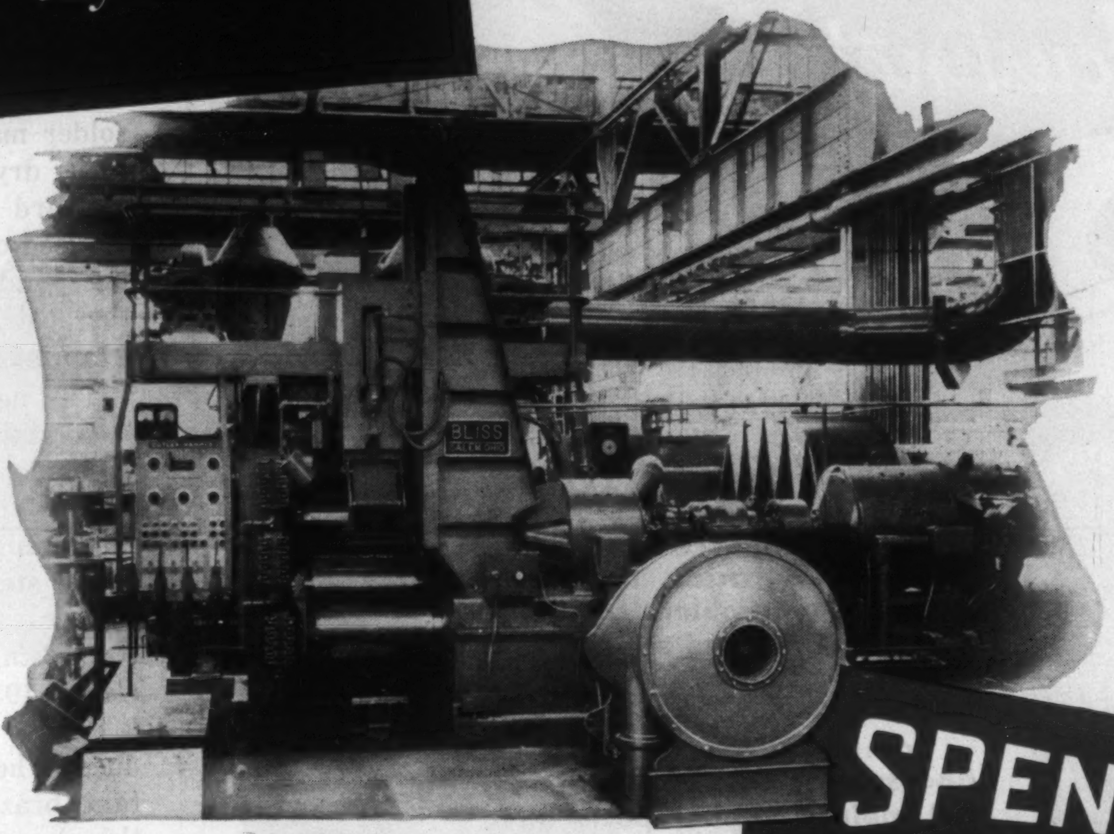
An 18 by 36-in. tack cloth has been marketed by *The Permacel Tape Corp.* for removing lint, dust, abrasive grain, metal and paint particles in all finishing and refinishing operations. Permacel 091 is designed to pick up and hold foreign material, preventing spreading or scattering of unwanted particles. Treated with a special impregnant, the cloth is particularly effective in finishing or refinishing cars, trucks, busses, aircraft, radios, boats, furniture and homes.

Brazing, Soldering and Hard Facing Materials

Two new brazing developments, a fluxless aluminum solder and hard facing materials in paste form have recently been marketed. They are: 1) stainless steel brazing alloy in paste form; 2) a flux permitting brazing of chromium

E. W. BLISS CO.

says:



SPENCER
HARTFORD
TURBOS

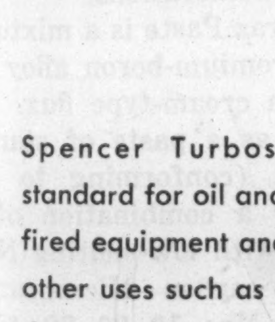
"... we have used SPENCER whenever a large amount of air is required under low pressure."

This E. W. Bliss rolling mill produces copper and brass strip at speeds from 500 to 1000 feet per hour. The 15 HP Spencer Turbo furnishes air for the air wiper which consists of two nozzles—one above and one below the moving strip. The blast of air removes and reclaims coolant liquid from the strip.

Spencer Turbos provide reliability and low maintenance because they are all metal; have wide clearances, and only two bearings to lubricate. No special foundations required; discharge may be in any one of four positions; control is by blast gate and power is proportional to the amount of air used.

The air delivered is as clean as the air in the room;—cleaner if you use Spencer filters on the intake.

Spencer Turbos are standard for oil and gas-fired equipment and 100 other uses such as agitation, gas boosting, scale blowing, spraying and ventilating. Ask for Bulletins No. 126 and 107.



THE SPENCER TURBINE COMPANY

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Manufacturers of Turbo-Compressors and Heavy Duty Vacuum Cleaners

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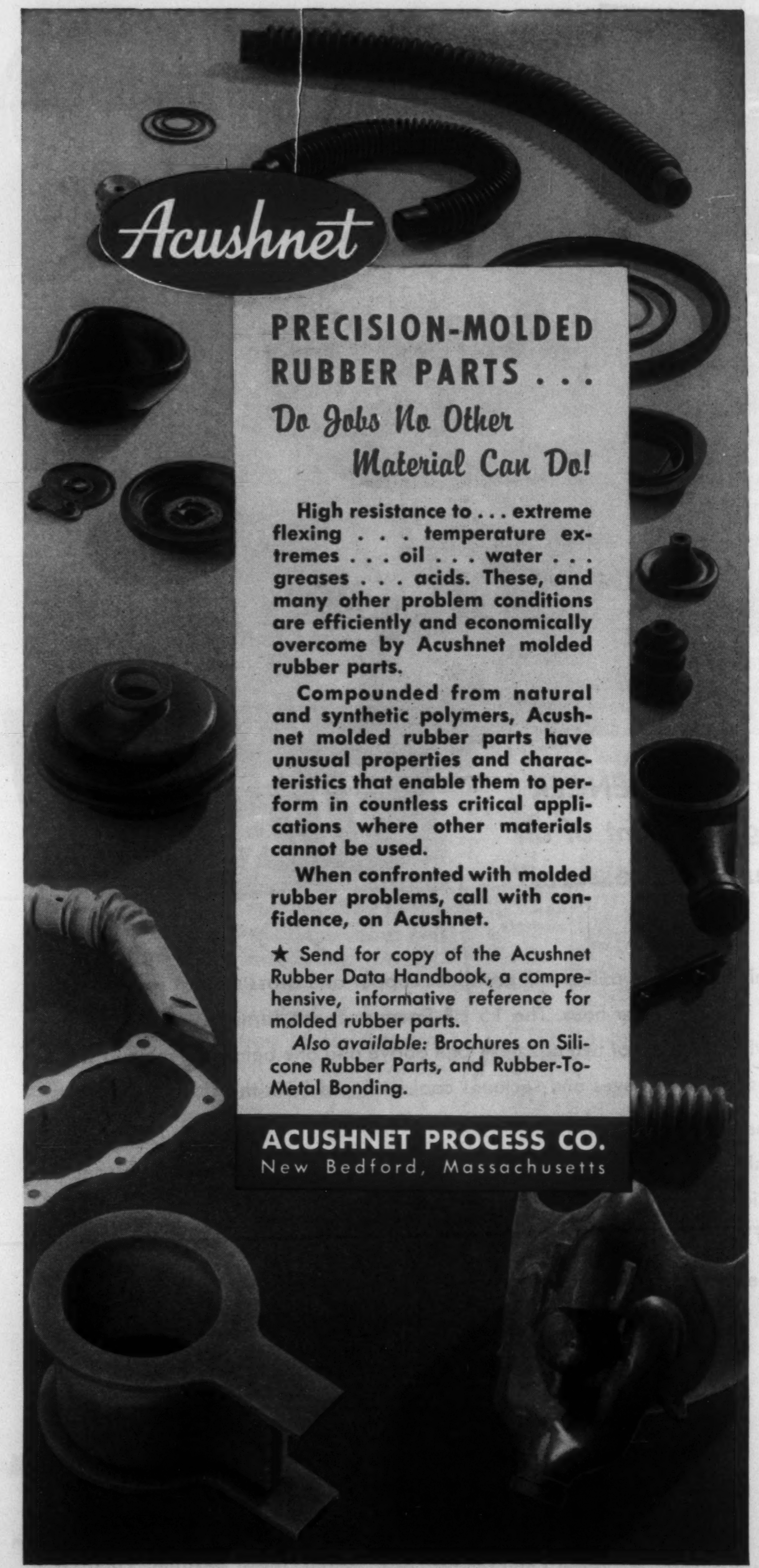

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Do Jobs No Other Material Can Do!

High resistance to . . . extreme flexing . . . temperature extremes . . . oil . . . water . . . greases . . . acids. These, and many other problem conditions are efficiently and economically overcome by Acushnet molded rubber parts.

Compounded from natural and synthetic polymers, Acushnet molded rubber parts have unusual properties and characteristics that enable them to perform in countless critical applications where other materials cannot be used.

When confronted with molded rubber problems, call with confidence, on Acushnet.

★ Send for copy of the Acushnet Rubber Data Handbook, a comprehensive, informative reference for molded rubber parts.

Also available: Brochures on Silicone Rubber Parts, and Rubber-To-Metal Bonding.

ACUSHNET PROCESS CO.
New Bedford, Massachusetts

Address all communications to 750 Belleville Ave., Bedford, Mass.

For more information, turn to Reader Service Card, Circle No. 406

carbide without a protective atmosphere; 3) a fluxless aluminum solder material which also serves as a dry bearing material; and 4) hard facing pastes which can be used on any metal whose melting point is higher than that of the paste, 1850 F.

Stainless steel brazing paste

The new paste form of Nicrobraz stainless steel brazing alloy is recommended for stainless steels, nickel-base, cobalt-base, and similar alloys as well as low alloy steels, carbon steels and copper. Developed by *Stainless Processing Div., Wall Colmonoy Corp.*, 19345 John R St., Detroit 3, Mich., the alloy is said to produce a heat- and corrosion-resistant brazed joint and provide a thin corrosion-resistant overlay in the area surrounding joints. It can be applied by brushing, dipping or any other type of hand or mechanical application when properly diluted to suit the application method. It can be torch or induction brazed where use of vacuum or controlled atmospheres is not feasible because of cost or design considerations.

Nicrobraz Paste is a mixture of nickel-chromium-boron alloy powder and a cream-type flux. It is available as a paste of standard Nicrobraz (conforming to AMS 4775), or a combination of the new flux with low-melting Nicrobraz, low-carbon Nicrobraz, or Nicrobraz Nos. 10, 20, 30, 45, 50, 60, 120, 140, or 150. It is available with three variations in flux-to-metal ratios. The flux can be removed with cold water, hot water, steam or flux removal chemicals.

Brazing cemented chromium carbide

Use of a brazing flux containing powdered boron now permits brazing of cemented chromium carbide without a protective hydrogen atmosphere, resulting in obvious production economies. The technique is expected to mean

felt..

Strip of felt from the molding press

molded into special shapes

American *felts* are moldable felts. Molded felt parts eliminate fabricating problems of stitching, cementing or stapling. They also provide one-piece integrated assemblies at lower cost for superior service where a compact, permeable shaped part is needed which will breathe, cushion, filter, seal, wick or lubricate. Review your material requirements and let our engineers apply this property of felt to your new design projects or to existing parts.

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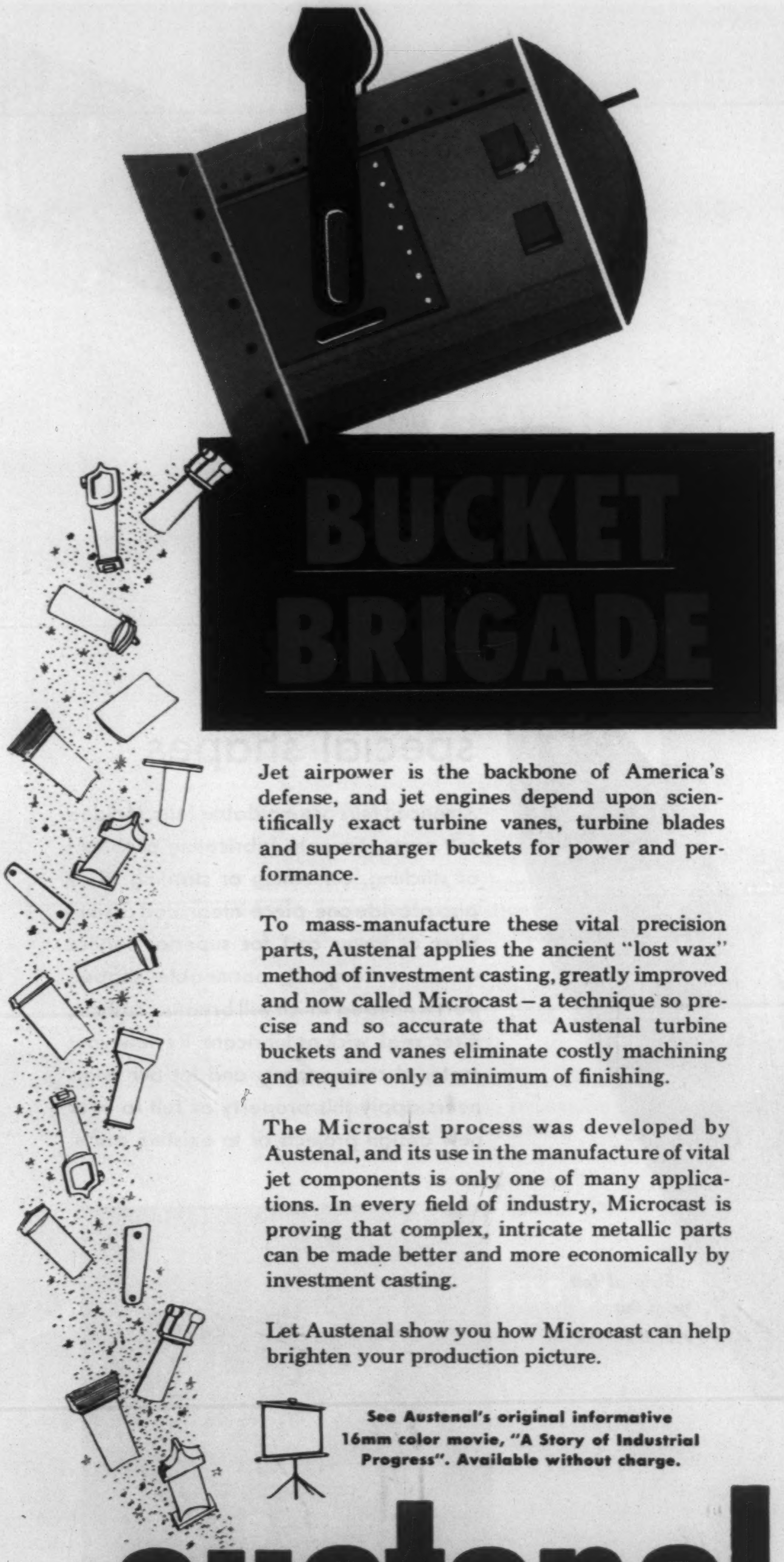

Jet airpower is the backbone of America's defense, and jet engines depend upon scientifically exact turbine vanes, turbine blades and supercharger buckets for power and performance.

To mass-manufacture these vital precision parts, Austenal applies the ancient "lost wax" method of investment casting, greatly improved and now called Microcast—a technique so precise and so accurate that Austenal turbine buckets and vanes eliminate costly machining and require only a minimum of finishing.

The Microcast process was developed by Austenal, and its use in the manufacture of vital jet components is only one of many applications. In every field of industry, Microcast is proving that complex, intricate metallic parts can be made better and more economically by investment casting.

Let Austenal show you how Microcast can help brighten your production picture.

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wider use of cemented chromium carbide in the 600 F temperature range, where it could not be used before due to lack of a suitable joining method. The flux, developed by *Handy & Harman*, 82 Fulton St., New York 38, is said to promote good wetting and bonding between cemented chromium carbide and silver alloy filler metals. Boron, being a strong reducing agent, appears to have outstanding ability to dissolve the tough chromium oxide film encountered in chromium carbide. The developmental work was carried out at Carboloy Dept. of General Electric on Carboloy grade 608 material. Several silver alloy filler metals were tried, the best results being obtained with the boron-containing flux and Type EB silver alloy filler metal (57 Ag, 33 Cu, 7 Sn and 3% Mn).

Fluxless aluminum solder

A combination low melting point fluxless aluminum solder or welding rod, which is also a dry bearing metal requiring no lubrication or coolant in friction or chafing applications has been developed by *Chemalloy Electronics Corp.*, Santee, Calif. It is derived from a blend of 87 zinc, 5 aluminum, 3 tin and 5% lead, thoroughly cleansed and homogenized with muriatic acid at a foundry temperature of 1500 F. The resulting material is said to penetrate surface oxides and visibly undergo capillary action in the parent metal. Aluminum surfaces tinned with the material are said to join readily with self-soldered tinned metals of any kind other than the aluminum itself. The metal melts at 600 F permitting use of torch equipment and a minimum of skill. The low temperature also permits its use with thin gages of aluminum.

According to the company, the material, when placed in rotating and stationary chucks of a lathe withstands friction noiselessly and without emitting heat. It has also withstood 20% salt spray

Hand-split mica from selected grades is scarce—almost all imported.

Treated and untreated continuous machine-made sheet mica now freely available in capacitor grades

Revolutionary new capacitor material offers cost savings up to 90%

. . . with improved performance in both stacked and rolled capacitors. Two new products developed by Mica Insulator Company offer many important advantages, savings and new design opportunities in stacked and rolled capacitors.

These new materials are Capacitor Grade Isomica® and Samica® machine-made continuous, 100% pure mica. Capacitor Grade Isomica is treated and impregnated with special high-temperature resins. Capacitor Grade Samica is a manufactured continuous, pure mica product and may be impregnated by the user.

Better stacked capacitors at lower cost. Previously only high grades of costly natural mica could be used in stacked capacitors. Supply was, and continues to be extremely limited. Capacitor Grade Isomica and Samica, available in unlimited quantities, may now be used in many stacked capacitor applications in jet aircraft ignition and electronic systems, as well as high-powered ground radar, etc. Use of these new materials makes possible stacked capacitors which are much less costly, easy to manufacture by automatic techniques.

Better performance in rolled capacitors. In rolled capacitors, organic paper and other materials used were subject to failure at high temperatures. Capacitor Grade Isomica and Samica make possible rolled capacitors that perform well over a wide temperature range . . . in many cases mean a reduction in size and weight for the same electrical rating.

Important savings, opportunities. Capacitor Grade Samica is freely available in sheets 36" wide, tapes or punched pieces. Capacitor Grade Isomica is available in sheets 36"x36" or fabricated pieces. They offer you manufacturing economies and lower material costs, inventory savings, new design possibilities in both miniature and large sizes, better physical and electrical properties, and alleviate dependence on foreign sources of supply.

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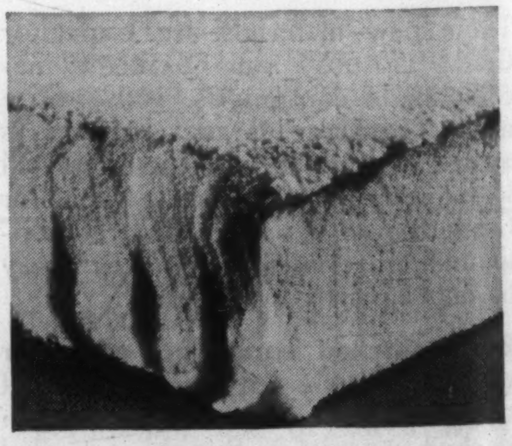
tests for periods exceeding 300 hr without more than a protective crust forming, which can be removed.

Hardfacing pastes

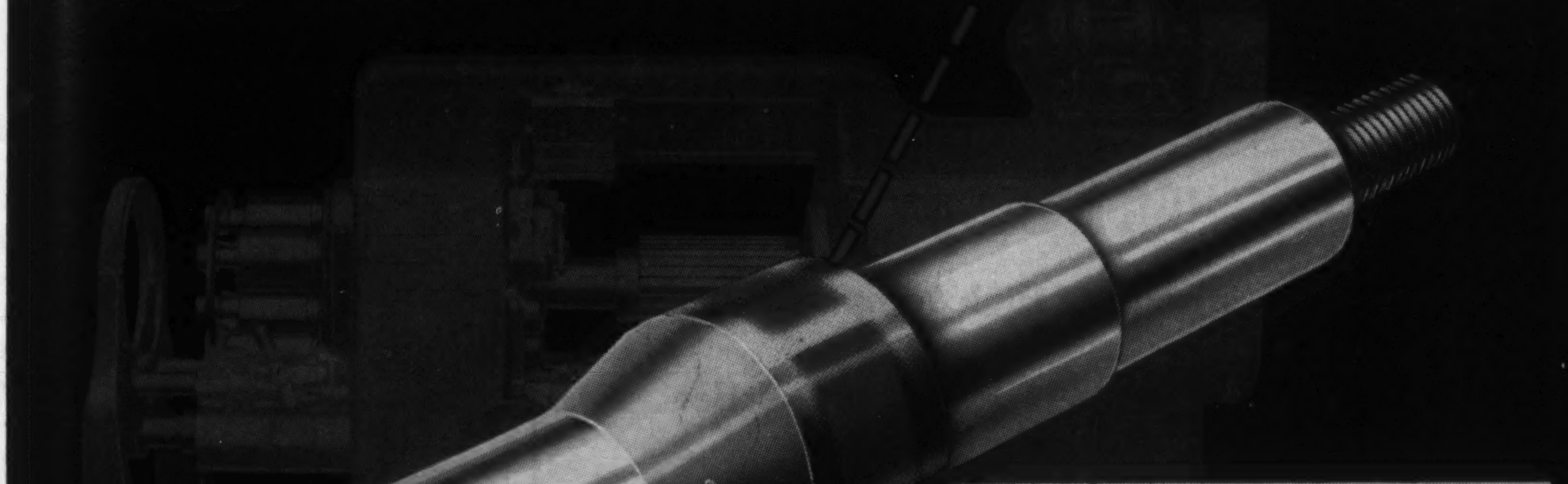
Hardfacing pastes, said to produce deposits of high hardness and abrasion resistance on any metal whose melting point is higher than 1850 F have been marketed by *Western Carbide Corp.*, subsidiary of Superweld Corp., 6840 Vineland Ave., No. Hollywood, Calif. Hardness of treated surfaces range from Rc 55 to 61. Designated Hi-C 60 Ruf-Nek, the material is a permanent suspension of powdered hardfacing alloy in a water base solution. It can be applied by spatula, brush, or by extrusion from a tube, followed by heating by flame or induction to the fusion point of the paste. Using gas flame, it can be applied to metal of less than 1/4-in. thickness. With proper induction heating, any thickness of metal can be hardfaced. The material is expected to find uses in manufacture and maintenance of farm tools, earth moving equipment and general industrial use.



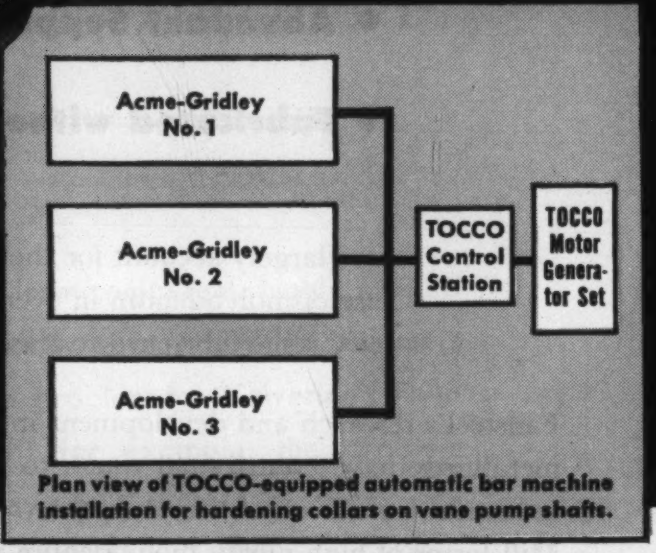
Flexible Vinyl Foam

A flexible vinyl foam material, available in any size or resiliency needed, is being marketed by *L. E. Carpenter & Co., Inc.*, Empire State Bldg., New York 1. Called Vicr-Foam, it is practically odorless, will not oxidize, dry out or

Pump Shafts Machined and Hardened



in *ONE* operation



Plan view of TOCCO-equipped automatic bar machine installation for hardening collars on vane pump shafts.

with TOCCO* Induction Heating

TOCCO-equipped 8-spindle Acme-Gridley Bar Automatics at a large automotive manufacturer's plant produce vane pump shafts for power steering units in one completely automatic operation!* No handling—no hardening cost except power!

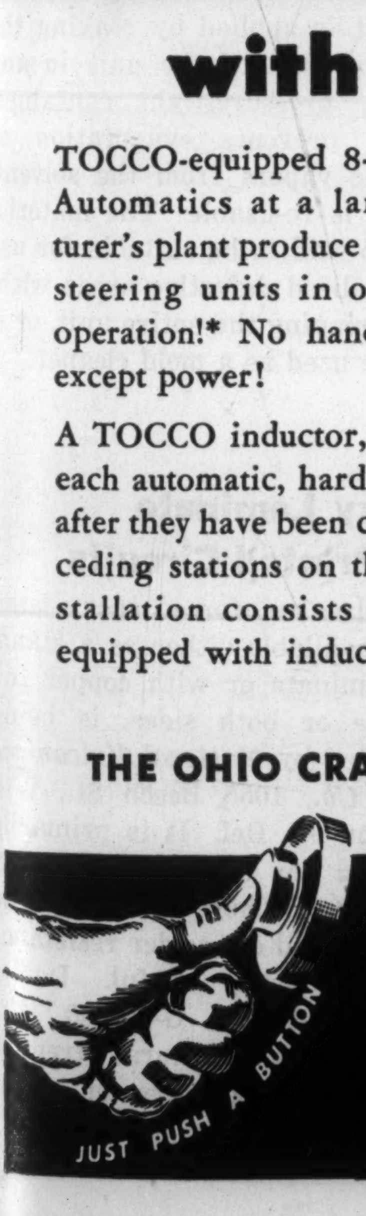
A TOCCO inductor, mounted at one station of each automatic, hardens collars on pump shafts after they have been completely machined at preceding stations on the same machine. Each installation consists of 3 automatic machines equipped with inductor coils powered by a 50 KW, 10,000 cycle TOCCO unit. Production from each installation is 360 shafts per hour.

Shafts are made of C 1144 and only the collar is hardened to prevent scoring the seal. TOCCO's rapid heating confines the hardened area to the surface of the collar leaving the rest of the shaft unaffected.

If your products or their components require heat treating, soldering, brazing or heating for forging, it will pay you to investigate TOCCO for better, faster production at lower unit costs.

**A Patented Process*

THE OHIO CRANKSHAFT COMPANY



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. . . largely account for the ever-increasing use of molybdenum in everything from electronic tube parts to glass furnace electrodes.

Fansteel's research and development in powder metallurgy have contributed much to the greater industrial utilization of this and other refractory metals. Mill forms of high purity molybdenum make its application more feasible and economical. Fansteel ships bar, sheet, wire and similar forms of molybdenum for countless industrial uses.

In addition Fansteel maintains modern facilities for part and product fabrication—forming, stamping, bending, deep drawing, forging, machining, brazing, welding, assembling, finishing—according to customer specification.

Fansteel engineers can assist you in the design and fabrication of molybdenum components. Their recommendations regarding refractory metals are yours for the asking.

"Fansteel Metallurgy", a journal devoted to refractory metals, will be sent to you upon receipt of your name and address.

FANSTEEL METALLURGICAL CORPORATION
NORTH CHICAGO, ILLINOIS, U.S.A.

K552A

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harden, has high elasticity and durability. It is oil resistant, heat resistant and will not support combustion. The material is said to be low in cost, and can be heat sealed to other plastics. Available in continuous slab colors to specification, the foam can be laminated directly to plastics fabrics to form cushion backing for furniture upholstery.

Stripper Solvent for Plastics

A new stripper solvent, said to allow salvage of valuable parts from defective units potted in cured epoxy or polyester resins, has been marketed by *Mona Industries, Inc.*, Paterson 4, N.J. Called Monastrip EP, the solvent is non-corrosive and non-flammable. It is applied by soaking the unit or part of the unit in any closed, pressure-tight container, which prevents evaporation of volatile vapors from the solvent, which is re-usable. The material is also said to be suitable for use on localized defective areas without stripping the entire unit, or it can be used as a mold cleaner.

Epoxy Laminate for Printed Circuits

A glass reinforced epoxy laminate, available either as a standard laminate or with copper foil on one or both sides, is being marketed by *National Vulcanized Fibre Co.*, 1055 Beech St., Wilmington 99, Del. It is primarily intended for electrical and electronic uses where its high bond strength and dip solder resistance are particularly useful. Designated Phenolite G-10-860, the laminate has a flexural strength at room temperature of about 50,000 psi, and approximately 50% of this strength is retained

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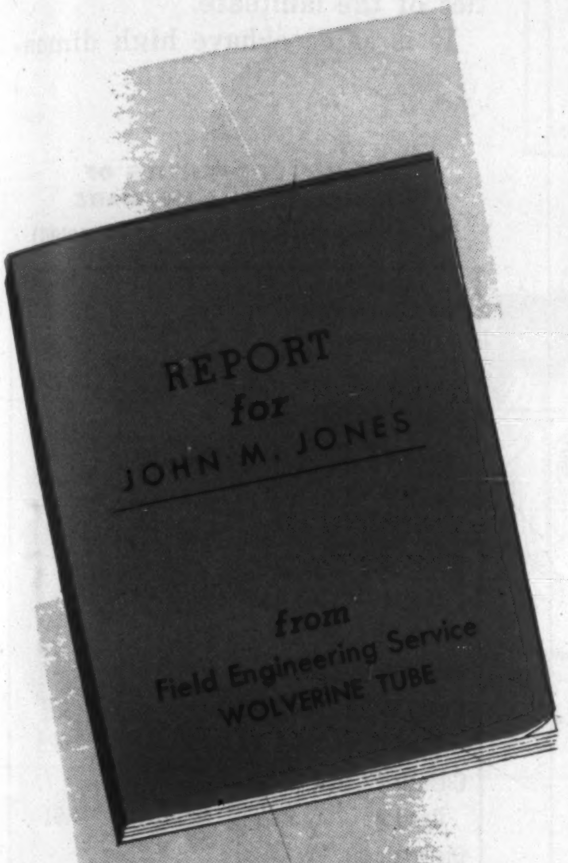

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GOETHE

. . . and good advice from competent, highly trained tubing technicians is exactly what Wolverine customers get when they bring a problem to Wolverine's Field Engineering Service. If, for example, the problem concerned aluminum they would receive information on alloys, fabrication, applications.

Wolverine's aluminum products—tubing and extruded shapes—are the result of years of metalworking experience. They are available in popular alloys, are held to rigid tolerances, will meet the most exacting specifications.

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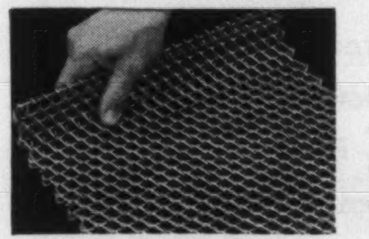

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If you use woven wire conveyor belts for continuous heat treating, annealing, sintering or any other operations up to 2100° F, we challenge you to send for this FREE SAMPLE of Cambridge belting—and make these comparisons to any other brand:

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Once you've done so, we think you'll agree that Cambridge offers you more . . . because they're made better; that means longest belt life and lowest belt maintenance for you.

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after exposure to 265 F temperatures for 1 hr. The accompanying table lists typical physical properties of the laminate.

It is said to have high dimen-

TYPICAL PROPERTIES OF PHENOLITE G-10-860—BARE
(1/8-in. thick laminate except where noted)

Flex str, psi (flatwise)	
Lengthwise	58,300
Crosswise	49,200
Impact str, ft-lb/in. (Cond E–48/50, edgewise)	
Lengthwise	9.1
Crosswise	6.8
Water absorp, % gain (Cond E–1/105 followed by Cond D–24/23)	0.12
Bond str, lb-Cond A	1940
Dissip factor, 1 megacycle	
Cond A	0.023
Dielectric Const, 1 megacycle	
Cond A	4.61
Dielectric str, kv	
(Parallel to lam)-Cond A	45
Dielectric str, v/mil	
(Perpendicular to lam)-Cond A[1]	815
Arc resist, sec-Cond A	23
Insul resist, megohms	
(1 1/16 x 1 1/8-in. samples tapered pine 3/16-in. holes on 1/2-in. centers)-Cond A	1,000,000
Surface resist, megohms	
Cond C–96/30/95	6,030,000
Density	1.70
Flex str, %	
(Retained after exposure to 265 F for 1 hr, tested at 265 F, flatwise)	
Lengthwise	63
Crosswise	57

TYPICAL PROPERTIES OF COPPER-CLAD LAMINATE

Bond str, 1-in. wide strip, lb	8½–9
Hot solder resist, sec	
(1- x 1-in. samples floated on solder both surfaces)	
482 F	730
500 F	730
518 F	730
Surface resist, megohms/sq cm	
Cond C–96/30/95	294,000

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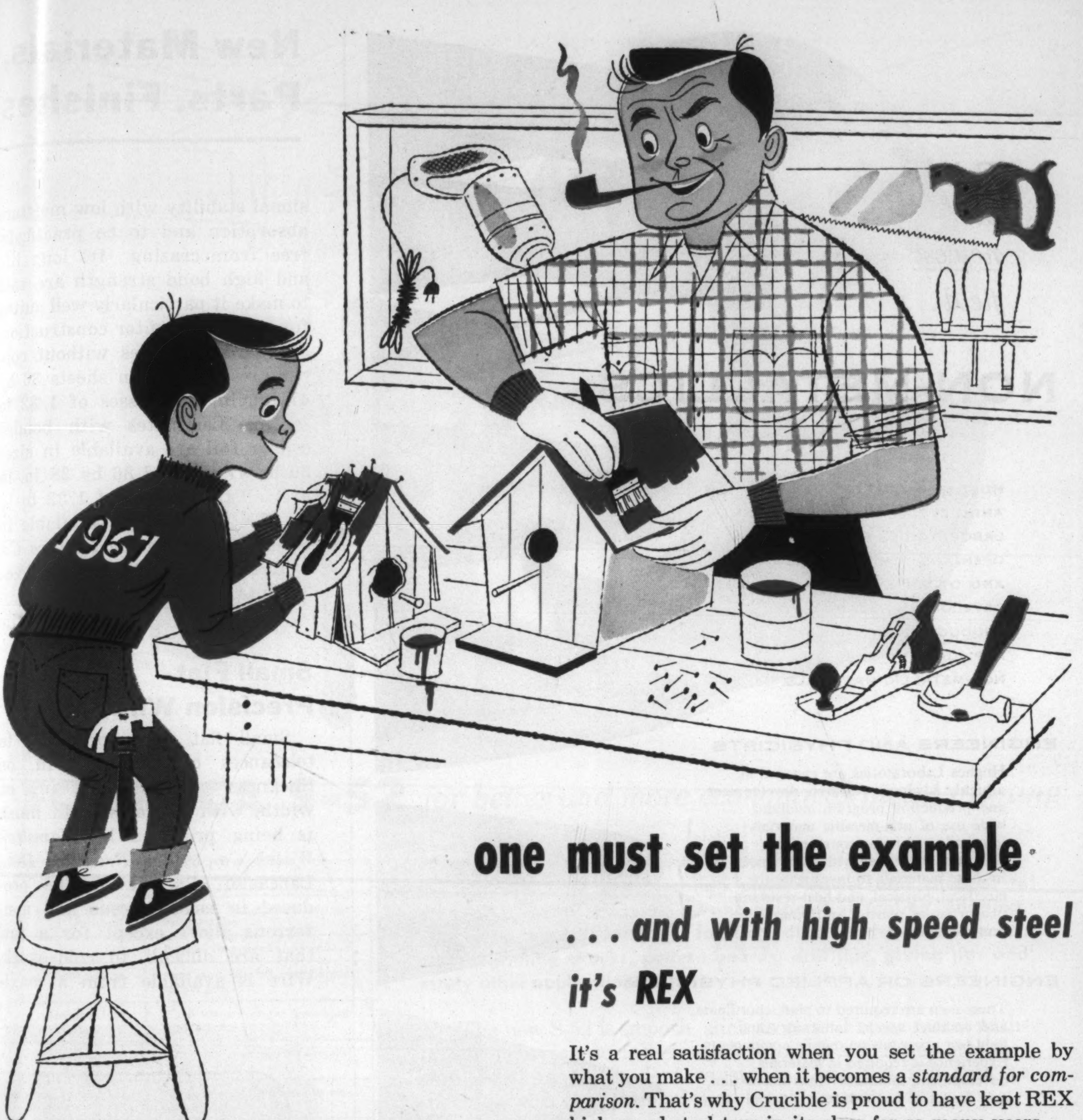
[1] *Laminate 1/8 in. thick.*



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. . . *and with high speed steel it's REX*

It's a real satisfaction when you set the example by what you make . . . when it becomes a *standard for comparison*. That's why Crucible is proud to have kept REX high speed steel tops in its class for so many years.

But don't take our word for REX's superiority. Try it on your own work. Compare its structure, finish, hardenability, carbide distribution and general uniformity. You'll see for yourself why it's the *standard* wherever high speed steels are used.

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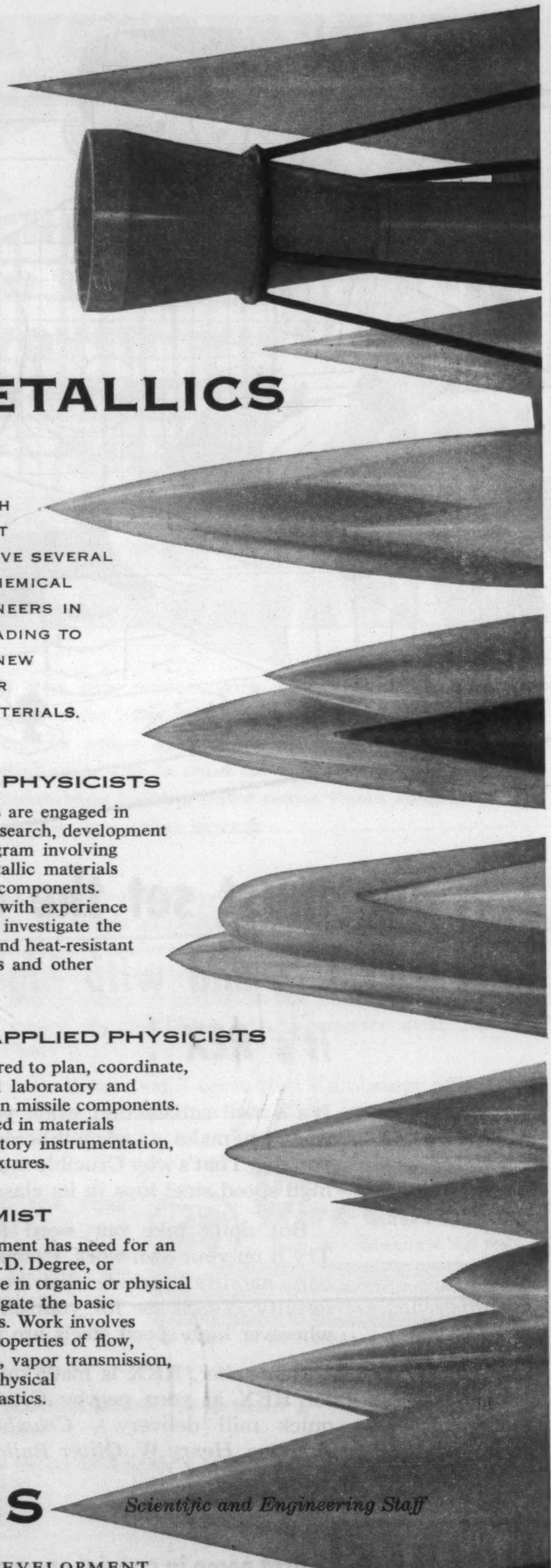

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NON-METALLICS

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APPLICATIONS FOR
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Hughes Laboratories are engaged in a highly advanced research, development and production program involving wide use of non-metallic materials in missile and radar components. The need is for men with experience in these materials to investigate the electrical, physical, and heat-resistant properties of plastics and other non-metallics.

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These men are required to plan, coordinate, and conduct special laboratory and field test programs on missile components. Experience is required in materials development, laboratory instrumentation, and design of test fixtures.

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The Plastics Department has need for an individual with a Ph.D. Degree, or equivalent experience in organic or physical chemistry, to investigate the basic properties of plastics. Work involves research into the properties of flow, mechanisms of cure, vapor transmission, and electrical and physical characteristics of plastics.

HUGHES *Scientific and Engineering Staff*

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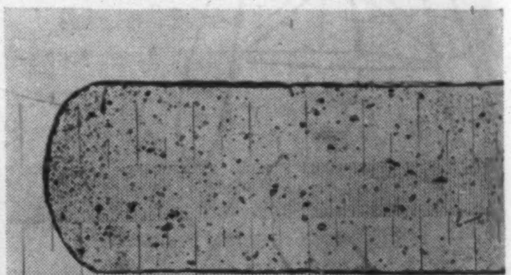
Culver City, Los Angeles County, California

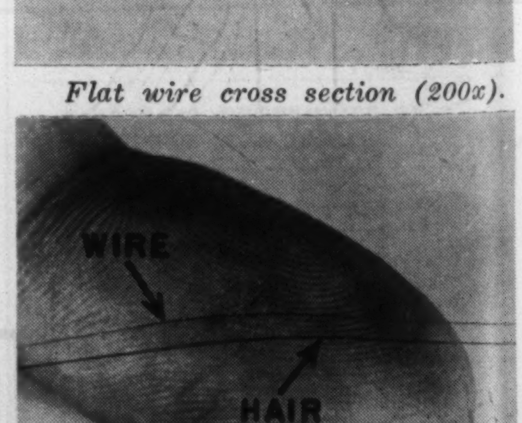
sional stability with low moisture absorption and to be practically free from crazing. Its long life and high bond strength are said to make it particularly well suited for use in computer construction. Standard laminates without copper are available in sheets 36 by 47 in., in thicknesses of 1/32 to ½ in. Laminates with bonded copper foil are available in sizes 36 by 47 in., and 36 by 38 in. in over-all thicknesses of 1/32 to ¼ in. The laminate is available in Canada from *National Fibre Co. of Canada, Ltd.*, 107 Atlantic Ave., Toronto, Ontario.

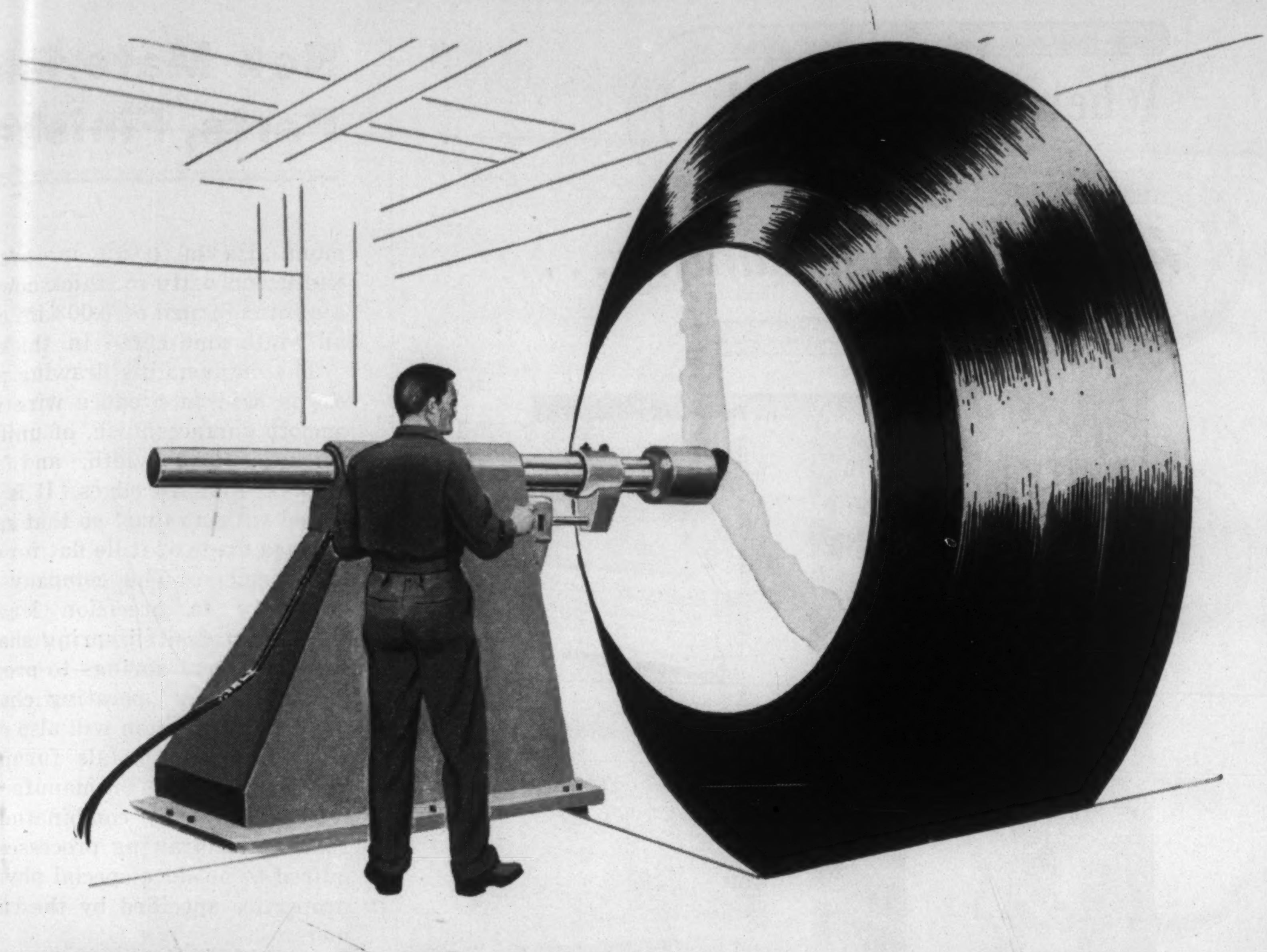
Small Flat Precision Wire

Small flat wire, produced to tolerances of ±0.00001 in. on thickness and ±0.001 in. on width, with mirror-smooth finish is being produced by *Hamilton Watch Co., Allied Products Div.*, Lancaster, Pa. It can be produced in most ferrous and nonferrous alloys except for a few that are difficult to cold work. Wire is available from a maxi-



Flat wire cross section (200x).





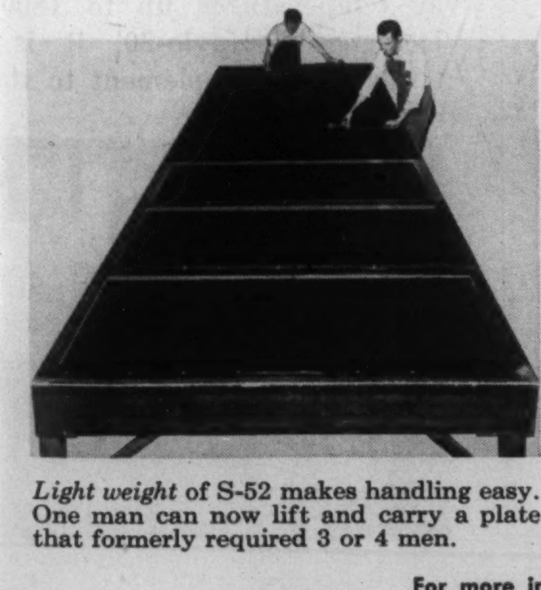
FORMICA S-52 *for better and more economical metal forming*

FORMICA S-52 IS:	which means:
smooth, scratch resistant	It will not transfer any surface irregularifies
flat	It's free from peaks and valleys
light weight	One man can lift and handle larger pieces
dent resistant	It's 8 times stronger than hard maple
economical	It's much cheaper than metal tooling plate
easy to machine	It's easier and cheaper to machine than any metal
corrosion resistant	It will not rust
friction resistant	Thin metal sheets can be formed and removed from S-52 dies without sticking, splitting or tearing

Formica S-52 laminated plastic is a much more economical forming material than metal tooling plate, easier and cheaper to machine. It's ideal for aviation and automotive tooling, gauging, templates, stretch forming, forming dies, hydro-press forms; metal spinning chucks, pattern boards, drill jigs, gluing jigs and many other applications.

The new S-52 is smooth, slick as glass. Forms metal without transferring surface irregularities. It's 8 times stronger than hard maple in dent resistance. And yet it's easy to machine with conventional metalworking tools.

Now available in sheet thicknesses up to 3″; widths 24″, 30″, 36″; lengths 42″, 60″, 72″, 84″, 96″. Sheets 36″ x 96″ in stock for prompt delivery. For further information on how you can use S-52 for better, more economical metal forming, write today for free bulletin 604 and data sheet. The Formica Co., 4678 Spring Grove Ave., Cincinnati 32, Ohio.



Light weight of S-52 makes handling easy. One man can now lift and carry a plate that formerly required 3 or 4 men.

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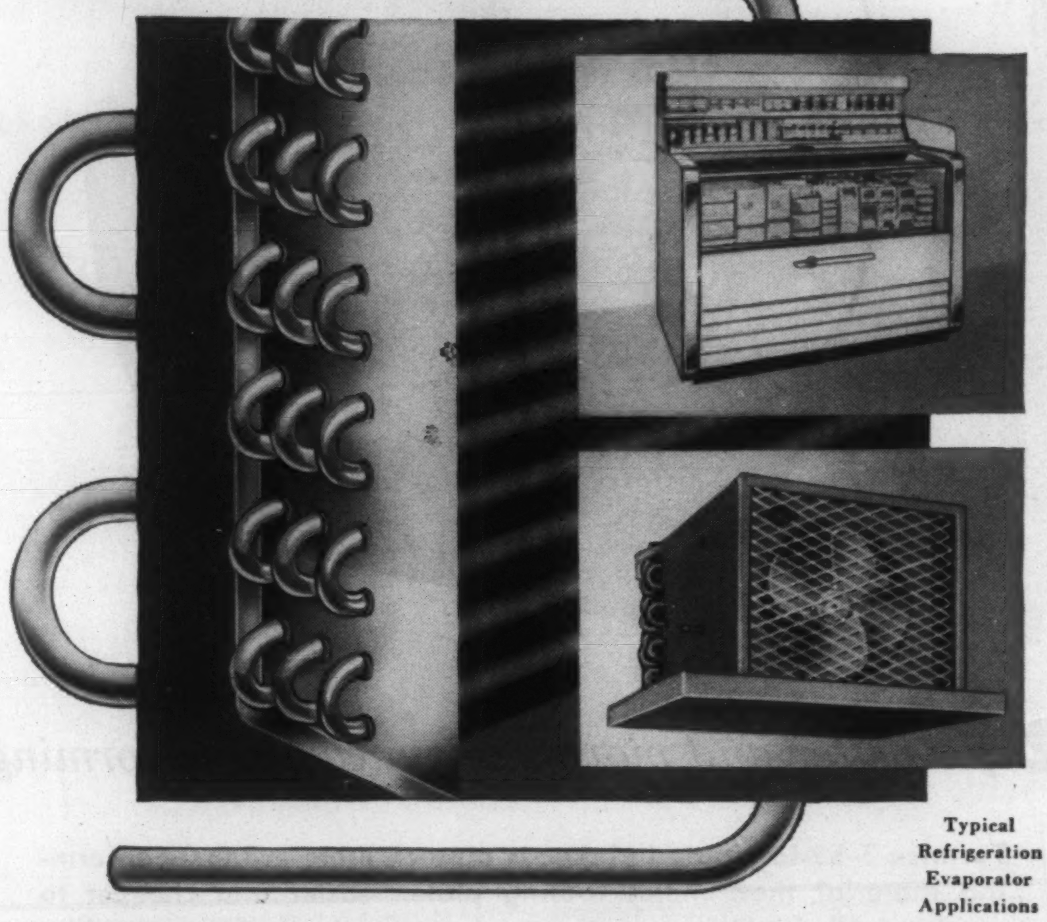


Typical Refrigeration Evaporator Applications

You Find *Confidence* in Performance!

In refrigeration or whatever the job is you have for copper tubing, you can depend on the precision quality of United Mill products. The difference is production control and processing.

Compare United quality and prompt deliveries. You get quality plus . . . including close tolerances, uniform temper and good clean outside and inside surfaces.

It costs no more to get the best copper tubing.

UNITED WIRE & SUPPLY CORPORATION
Providence 7, R. I. • Offices in Principal Cities

UNITED COPPER TUBING
"first in quality"

Permanently United

For more information, turn to Reader Service Card, Circle No. 343

New Materials, Parts, Finishes

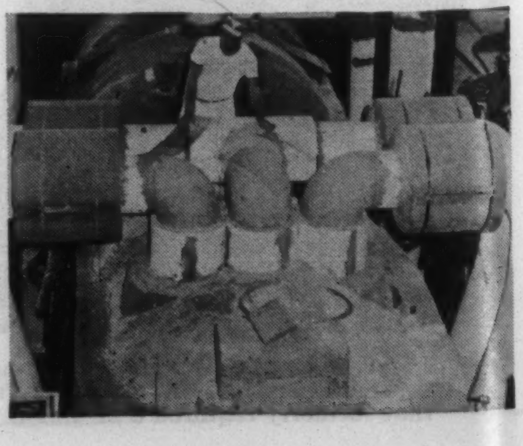
mum size of 0.019 in. over-all width and 0.010 in. thick down to a minimum size of 0.003 in. over-all width and 0.0007 in. thick.

The diamond die drawing process is said to produce wire with smooth surface finish, of uniform thickness and width, and with smooth, rounded edges. It is produced with no twist so that spiral springs made of it lie flat for ease of assembly. The company will cut wire to precision lengths, form it in desired spring shapes, and heat treat springs to produce desired spring operating characteristics. Hamilton will also draw the wire from metals furnished by the customer, or manufacture the wire by any combination of rolling and drawing processes required to produce special physical properties specified by the customer.

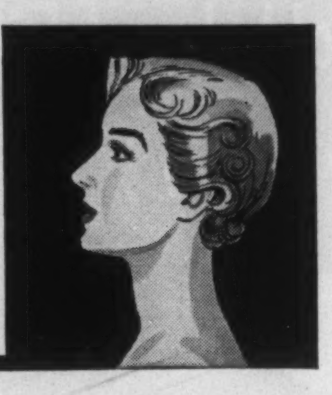
Suggested applications for the wire are for springs in precision timing elements, in high precision electrical and aneroid instruments, and in high sensitivity electrical relays. It also has possibilities as supporting elements in high-sensitivity torsion suspensions, such as those used in oscillograph galvanometers and in delicate torsion balances.

Block Insulation Good Up to 1800 F

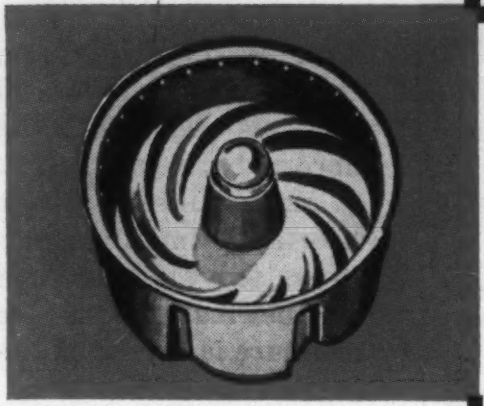
A hydrous calcium silicate insulation, available in block or pipe form, has been developed for use at temperatures up to 1800 F. Designated Kaylo-20, it is intended as a supplement to stand-



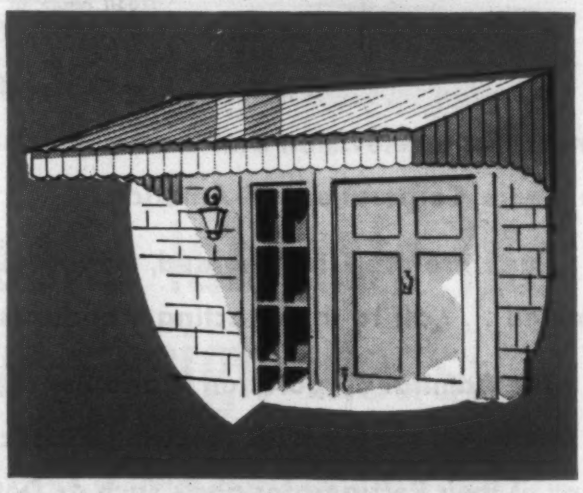
THERE'S A GLIDPOL* POLYESTER RESIN FOR EVERY PURPOSE



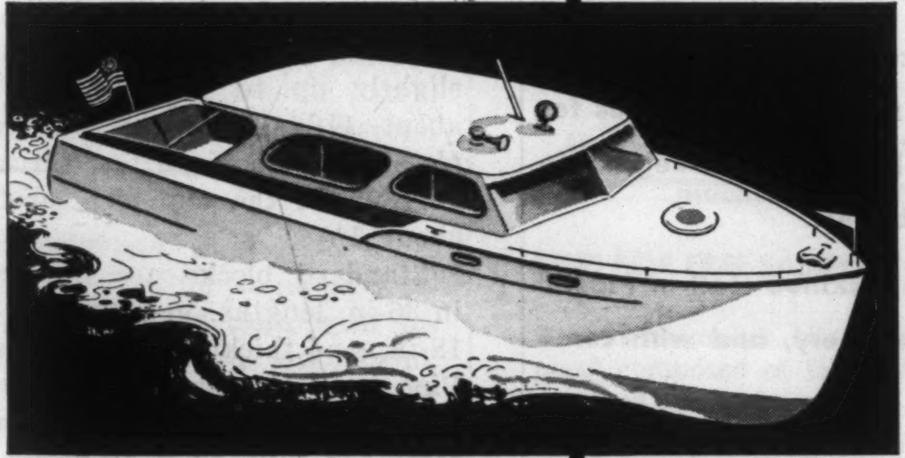
HAND LAYUP, ROOM TEMPERATURE-CURE MOLDING
Made of reinforced GLIDPOL resin, this eye-appealing display mannequin is molded and cured at room temperature without the introduction of heat.



MATCHED DIE MOLDING
Compression-molded at elevated temperature in a few minutes with GLIDPOL, this automatic washer tub has superior corrosion and alkali resistance.



LAMINATING WITH PIGMENTED STABLE RESIN. These colorful, weatherproof awnings, laminated with pigmented GLIDPOL, offer excellent light stability and permanent locked-in color.

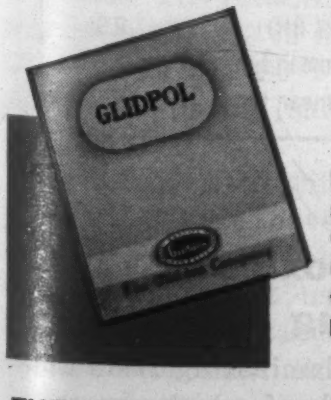


PROTECTIVE COATING APPLICATION
The wooden hull of this handsome cabin cruiser is coated with GLIDPOL to provide maximum water and abrasion resistance, hardness and lasting high gloss.

All of your service and molding requirements can be met by one of the GLIDPOL family of polyester resins. GLIDPOL provides superior wetting of the glass fibers, maximum corrosion resistance to water and most common chemicals with uniform quality from batch to batch.

Glidden-controlled manufacture of GLIDPOL helps insure rapid, uniform cure at elevated or room temperatures without cracking or crazing. You can use GLIDPOL in your laminating, molding, impregnating, casting, potting and coating operations.

*A Glidden Trade-Mark



For complete, detailed specification data on GLIDPOL resins, write (on your company letterhead) for Technical Bulletin MM-1255.

GLIDPOL
POLYESTER RESINS

QUALITY Glidden PRODUCTS

THE GLIDDEN COMPANY • INDUSTRIAL FINISHES DIVISION • 11005 MADISON AVENUE, CLEVELAND 2, OHIO
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*For more information, turn to Reader Service Card, Circle No. 376

"Sure Sign of Excellence"

Molded and Finished by Sinko

We mold all Thermoplastics including NYLON and KEL-F* in sizes up to 60 oz.

* Trade name of M. W. Kellogg Co.

Pictured above is the assembled unit and components for a Television Dial we are producing in enormous quantities for the Radio Corporation of America.

Parts are precision molded, beautifully finished, and accurately assembled . . . all to the exacting standards set up for us by RCA.

The Admiral Corporation is another of America's leading manufacturers whom we supply with Precision Plastic Moldings. They look to us for many of their Refrigerator parts such as Defroster Push Buttons, Vegetable Crispers, Butter Storage Units, Lamp Guards, Knobs, etc.

The Sinko organization is made up of a highly skilled staff of Plastic Technicians, equipped with the most modern machinery, and with complete facilities for:

- Design and Engineering
- Injection Molding
- Mold, Tool and Die Making
- Metal-Plastic Assemblies
- Vacuum Distillation Plating
- 2 and 3 Color Plastic Spraying
- Hot Stamping, Painting
- Fabricating and Assembling

LET SINKO "KNOW-HOW" HELP SOLVE YOUR PLASTIC MOLDING PROBLEMS!

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GEORGE L. HERRICK CO.—15326 Lorain Ave.

For more information, turn to Reader Service Card, Circle No. 380

ard Kaylo insulation which has an upper service temperature ceiling of 1200 F. Produced by Owens-Illinois Glass Co., it is being distributed by *Owens-Corning Fiberglas Corp.*, Toledo 1, Ohio. Kaylo-20 is tinted pink to distinguish it from the standard white Kaylo. The materials are finding use where insulation must have a degree of mechanical strength and where a block insulation is required rather than a fibrous barrier.

While silicate materials will take up a small amount of water if wetted at room temperature, as the material is heated, the moisture is driven off and thermal insulating efficiency is restored. The insulator does not shrink or warp during wetting and drying. It is lightweight, has good mechanical strength, dimensional stability under heat and good workability. Kaylo-20 expands slightly up to temperatures of about 1100 F, and when completely enclosed in a test furnace at 1800 F, the material shrinks about 1½%.

Standard blocks are produced in 36-in. lengths, in widths up to 18 in., and thicknesses up to 3 in. Pipe insulation is produced in a range of thicknesses and diameters for pipe sizes from ½ to 39 in.

TYPICAL PROPERTIES OF KALO-20

Density, lb/cu ft	11
Comp str, psi	150
Comp str to 2% deformation, psi	100
Shrinkage, 16 hr at 1800 F, %	Less than 1.9
Flex str, psi	60
Moisture absorp, as % vol (6 hr at 120 F, 90% RH)	0.9
K factor at 100 F mean temp	0.40
K factor at 900 F mean temp	0.90

White Epoxies for Tooling

An epoxy laminating resin and gel coat, both of which are said to be a brilliant white, have been

New Materials, Parts, Finishes

developed by *Rezolin, Inc.,* 5736 W. 96th St., Los Angeles. L-904, the laminating resin, is a thermosetting modified epoxy with high dimensional stability, good liquid life and high impact, flexural, compressive and tensile strengths. It is said to be easy to handle and easy to apply using standard laminating techniques.

L-914, the gel coat, is said to have good hanging properties and will harden with high gloss on a laminated surface at ambient room temperature. It is said to be well suited for achieving continuity of surface properties.

Two Silicone Rubber Gums

Two silicone rubber gums, one featuring minimum shrinkage during vulcanization, the other a reinforced gum or master batch, have been marketed in commercial quantities by *Dow Corning Corp.,* Midland, Mich.

Low shrinkage gum

Silastic 430 Gum is an easy-to-compound silicone gum with inherent low set and low shrink characteristics. Properly cured, it provides tough, high strength parts serviceable from —70 to 500 F. Low shrink during vulcanization and cure often makes it possible to use molds designed for conventional organic rubber parts. For example, a silicone rubber compounded of 100 parts of the new gum, 125 parts Celite 270, and 2.5 parts Luperco CSF or Cadox TS vulcanizing agent, shrinks only 1.5% in molding and after 24 hr at 480 F shows an additional linear shrinkage of only 2%.

Parts fabricated with 430 Gum are also said to have low compression set. Since this low set is obtainable without use of toxic additives, it is suitable for use in contact with foods, drugs or cosmetics. Low compression set is obtained after a relatively short

1. Novoply surface is remarkably flat, and its mosaic-textured look makes it a handsome panel for decorative use. **2.** Top and bottom surface plies are precision-made wood flakes. **3.** Center ply is of specially graded wood chips. Both flakes and chips are resin-coated and -impregnated.

SEE HOW THIS

3-ply wood-plastic laminate fits in with *your* design ideas!

United States Plywood's NOVOPLY is rigid, super-flat, easy to work, mechanically strong, has tremendous design potential

SEND FOR FREE SAMPLE AND ENGINEERING DATA BOOKLET—Test it yourself!

What is Novoply? Novoply is a 3-ply panel composed of faces of specially prepared wood flakes and a core of wood chips, all resin-impregnated, and molded under heat and pressure to make a very dense, hard, flat panel.

Novoply advantages. It's tremendously strong, stiff, highly water-resistant, with unusual dimensional stability in all directions. Novoply is very stable, expanding and contracting less than 0.3% even under conditions of extreme humidity. It's good *both* sides, glues readily, fabricates easily, is well adapted to modern, high-speed woodworking equipment. Its moisture resistance and 3-ply construction make it extremely flat and warp-resistant.

Novoply is being used as a core stock for high-pressure laminates such as Micarta®, as a core for veneered furniture, as practically warp-free sliding doors for closets, as wall paneling and counter fronts, and for decorative uses and sliding doors in furniture.

NOVOPLY PANEL SPECIFICATIONS: Thickness: ¾"; **Sizes:** 24" x 72", 24" x 96", 30" x 48", 30" x 60", 30" x 72", 36" x 72", 48" x 48", 48" x 72", 48" x 84", 48" x 96"; also cut-to-size for volume users from panels 6' x 12' and 4' x 16'. Available in ⅜", ⅝", 11/16", 1" thicknesses, sizes 48" x 96", and other sizes. **Important Note:** Only slight extra cost for long-length Novoply panels up to 16'.

NOVOPLY®
by Weldwood®
A product of
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World's Largest Plywood Organization
87 Distributing Units in Principal Cities

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RUSH my free sample of Novoply, and engineering data booklet detailing results of Novoply tests conducted by a famous independent research and testing laboratory.

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For more information, turn to Reader Service Card, Circle No. 314

CHEMICAL COMPOSITION OF HARD CARBIDE INGREDIENTS OF KENNAMETAL

	Tungsten Carbide (WC)	Titanium Carbide (TiC)	Tungsten-Titanium Carbide ($WTiC_2$)	Tantalum Carbide (TaC) with less than 5% CbC
Tungsten (W)	92.50% (min)		67.00-71.00%	
Titanium (Ti)		79.80-80.20%	18.00-21.00%	
Tantalum (Ta)				93.45-93.65%*
Carbon (C)	6.05-6.15%	19.20-19.60%	9.20-9.40%	6.35-6.55%
Columbium (Cb)				5.00% (max)

*Including CbC

MAXIMUM IMPURITY CONTENT

Free Carbon	0.05%	0.20%	0.05%	......
Fe	0.15%	0.40%	0.10%	0.10%
Mo	0.10%	......	0.30%	......
Ni	......	......	0.20%	......
Cb+Ta	0.50%	......	0.50%	......
Ti	0.20%	......	......	0.50%
Si	0.10%	0.10%	0.10%	......
Mn	0.10%	0.10%	0.10%	......
V	......	0.10%	......	......
Zr	......	......	......	0.20%
Sn	......	......	......	0.10%
W	......	0.20%	......	0.30%
Cr	......	0.10%	......	......
N_2	......	0.30%	......	......

These characteristics make KENNAMETAL* a unique material

Often, what is required to get an idea off the drawing board into production is a material that provides exceptional physical and chemical properties. Such a material is Kennametal . . . the hardest metal made.

The combined properties that Kennametal provides . . . shown in the accompanying tables . . . make this material stand uniquely alone. Each of the many grades of Kennametal provide a different combination of hardness, strength, and resistance to deflection, chatter, torque and vibration, erosion, abrasion, cavitation, corrosion, annealing, oxidation and shock.

Perhaps one or a combination of these characteristics is just what you need to get YOUR idea into production. We invite you to send for additional information about Kennametal. Write to KENNAMETAL INC., Latrobe, Pennsylvania, and ask for a copy of Booklet B-111.

7293

**Kennametal is the registered trademark of a series of hard carbide alloys of tungsten, tungsten-titanium and tantalum.*

RANGE OF PHYSICAL PROPERTIES OF VARIOUS GRADES	
Specific Gravity gms/cc	11.90-15.15
Thermal Conductivity (cal/°C/cm/sec)	.068-.207
Electrical Conductivity (% of Copper Standard)	4.3-10.0
Coeff. Thermal Expansion ($\times 10^{-6}$/°F up to 1200°F) ($\times 10^{-6}$/°C up to 650°C)	 2.5-4.0 4.5-7.2
Magnetic Permeability (μ Induction)	1.5-3.0
RANGE OF MECHANICAL PROPERTIES OF VARIOUS GRADES	
Hardness (Rockwell A) Hardness (Rockwell C) Hardness (Knoop-K100)	85-93 67-82 1700-2100*
Transverse Rupture (psi)	175,000-385,000
Young's Modulus of Elasticity (psi)	61,600,000-94,300,000
Compressive Strength (psi)	518,000-800,000
Torsional Strength (Shearing Stress psi)	100,000-186,000
Tensile Strength (psi)	To 150,000

*Partial Range

INDUSTRY AND KENNAMETAL
...*Partners in Progress*

For more information, turn to Reader Service Card, Circle No. 339

New Materials, Parts, Finishes

cure. For example, the above formulation exhibits a compression set of 35% after 22 hr at 300 F when cured 4 hr at 480 F, and a compression set of 25% when cured 24 hr at 480 F.

Compounded with suitable fillers, the material will also produce electrical insulating components which retain a high degree of dielectric properties in service at elevated temperatures, in high humidity or under severe weathering conditions.

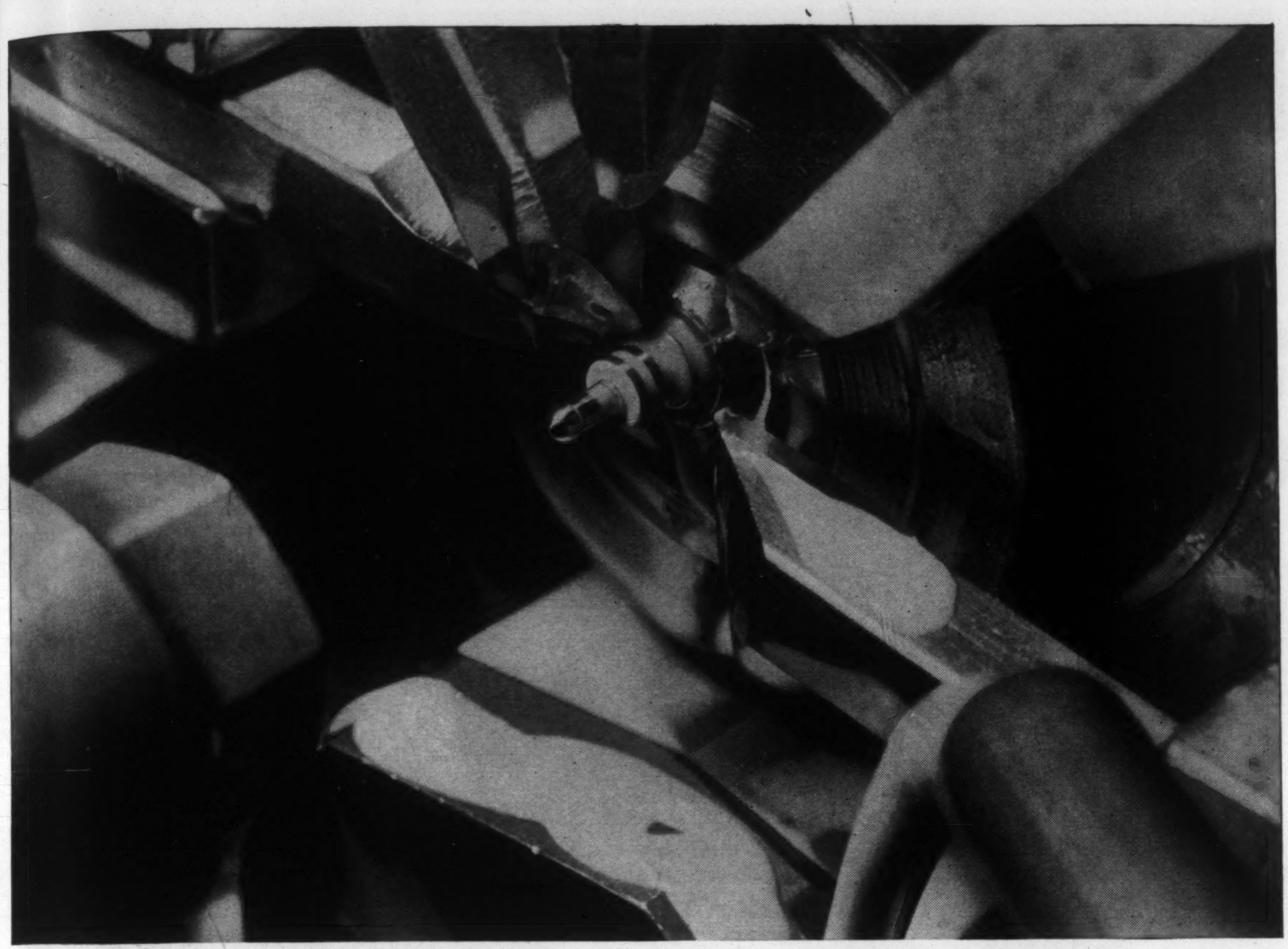
Master batch

Silastic 432 Base, containing 80% polymer-20% silica, is designed to facilitate compounding of rubbers serviceable from −70 to 500 F. It is a stabilized, master batch material which markedly reduces compounding time and assures reproducible results. It can be compounded either with additional reinforcing fillers or less costly extenders, and with vulcanizing agents.

Inherent low shrink and low compression set characteristics of the material eliminate the need for toxic additives. With properly selected filler, the material produces silicone rubbers with high dielectric properties and low water absorption. By adding vulcanizing agent only, the material cures to form a rubber with low hardness. The material can be compounded to produce silicone rubbers for mechanical goods, gaskets and seals, extrusions and wire coatings.

Heat Sealable VPI for Packaging

A heat sealable VPI (vapor phase inhibitor) paper has been developed by *Orchard Paper Co.*, 3914-24 Union Blvd., St. Louis 15, Mo. It is supplied as a 35-lb kraft sheet coated with 2 g of VPI per sq ft. It is available in standard rolls 36 in. by 200 yd, weighing approximately 48 lb per roll. Narrower rolls and sheet stock are available. Recommended proce-



TURNING "Berylco" Beryllium Copper rod in Swiss screw machines at Molded Insulation Company, Philadelphia, Pa.

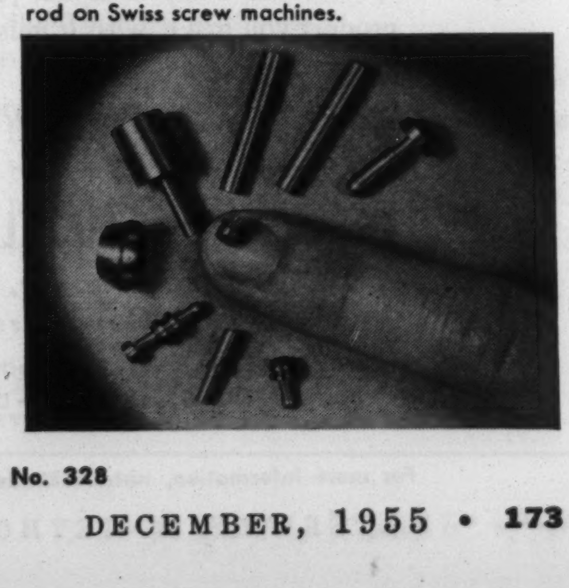
Machining "Berylco" Beryllium Copper is a run-of-the-mill operation at this plant

Beryllium copper has long been regarded—by people who have never tried it—as a difficult alloy to machine. Usually the reverse is true, as Molded Insulation Company can testify.

This manufacturer regularly produces a wide variety of small precision parts from "Berylco" Beryllium Copper. The use of most of these parts is classified; many are designed to improve electrical connectors and communications equipment. Drilling, turning and cutting are done on Swiss screw machines. The parts are also slotted, tapped and milled. Standard tools and drills are used, and no special tool set-up is necessary. Surface speeds run 200 fpm—or even higher on small diameter stock—and the best coolant has been found to be a good water-soluble oil. Clogging is no problem: in fact, the company finds more difficulty with brass and bronze in this respect.

From the beginning, The Beryllium Corporation worked closely with this producer, conducting special hardness and tensile tests and furnishing material that would run well on the Swiss machines. It will be glad to work with you, too. Write, phone—or, if you prefer, blueprint your problem—and let us suggest a solution.

MICROSCOPIC inspection.



TYPICAL PARTS produced from "Berylco" rod on Swiss screw machines.

THE BERYLLIUM CORPORATION BERYLCO®
Dept. 5-M, • READING 3, PENNA.
New York • Springfield, Mass. • Rochester, N.Y. • Philadelphia • Pittsburgh • Cleveland
Dayton • Detroit • Chicago • Minneapolis • Houston • San Francisco • Los Angeles
Representatives in principal world-trade centers

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How do you know you can't do it better with a..

RIVERSIDE

Phosphor Bronze

Bridge plates of cold rolled Riverside Phosphor Bronze are yet another example of the many applications for this "Workhorse" of the copper-base alloys.

But the mere fact that an alloy is phosphor bronze is not sufficient. To do the best job the alloy has to be a combination of the right composition and the right properties.

Helping you get the best possible combination for your specific needs is one of our jobs at Riverside. Tell us what product you make, what it must do, your machining or fabricating method, and then . . . "Put it up to Riverside." More than a century of experience with non-ferrous alloys will then go to work for you.

THE RIVERSIDE METAL COMPANY DIVISION
H. K. Porter Company, Inc.
Riverside, New Jersey
Philadelphia • East Orange, N. J. • Rochester, N.Y.
Hartford • Cleveland • Chicago • Detroit

A DIVISION OF **HKP** H. K. PORTER COMPANY, INC.

For more information, turn to Reader Service Card, Circle No. 375

New Materials, Parts, Finishes

dures for heat sealing to meet or approximate seam strength requirements of MIL-P-116 are as follows: for bar type sealing machines, 500 F, 2-sec dwell time and 60-lb pressure; for automatic sealing equipment, 600 F, ½-sec dwell time and 15-lb pressure. The material is said to be particularly well suited for packaging of spare parts for the automotive, farm equipment and aircraft industries.

One-Part Epoxy Adhesive

A new epoxy adhesive which requires no mixing and has a pot life of over 30 days has been developed by *Miracle Adhesives Corp.*, P. O. Box 466, New Philadelphia, Ohio. Called Epoxy Resin Complex #285, the material is sold ready-to-use and is designed for use where large amounts of adhesive are required in production processes. Elimination of the need for mixing a catalyst on the job reduces dangers from toxicity common to most epoxy catalysts. The following advantages derive from use of the one-part material: 1) losses from material setting-up in the pot are eliminated; 2) production stoppages necessary to mix a new batch are eliminated; 3) ease of application reduces production costs; 4) shear strength of over 3000 psi in metal-to-metal bonds have been attained.

Improved Alkyd for Baking Enamels

Improved color retention, high hardness and mar resistance, as well as high resistance to alkalies and household soaps, are claimed for enamels formulated with a new alkyd resin, Duraplex ND-76, developed by *Rohm & Haas Co., Resinous Products Div.*, Washington Sq., Philadelphia 5, Pa. Compared with formulations based on current high quality alkyd resins, enamels made with

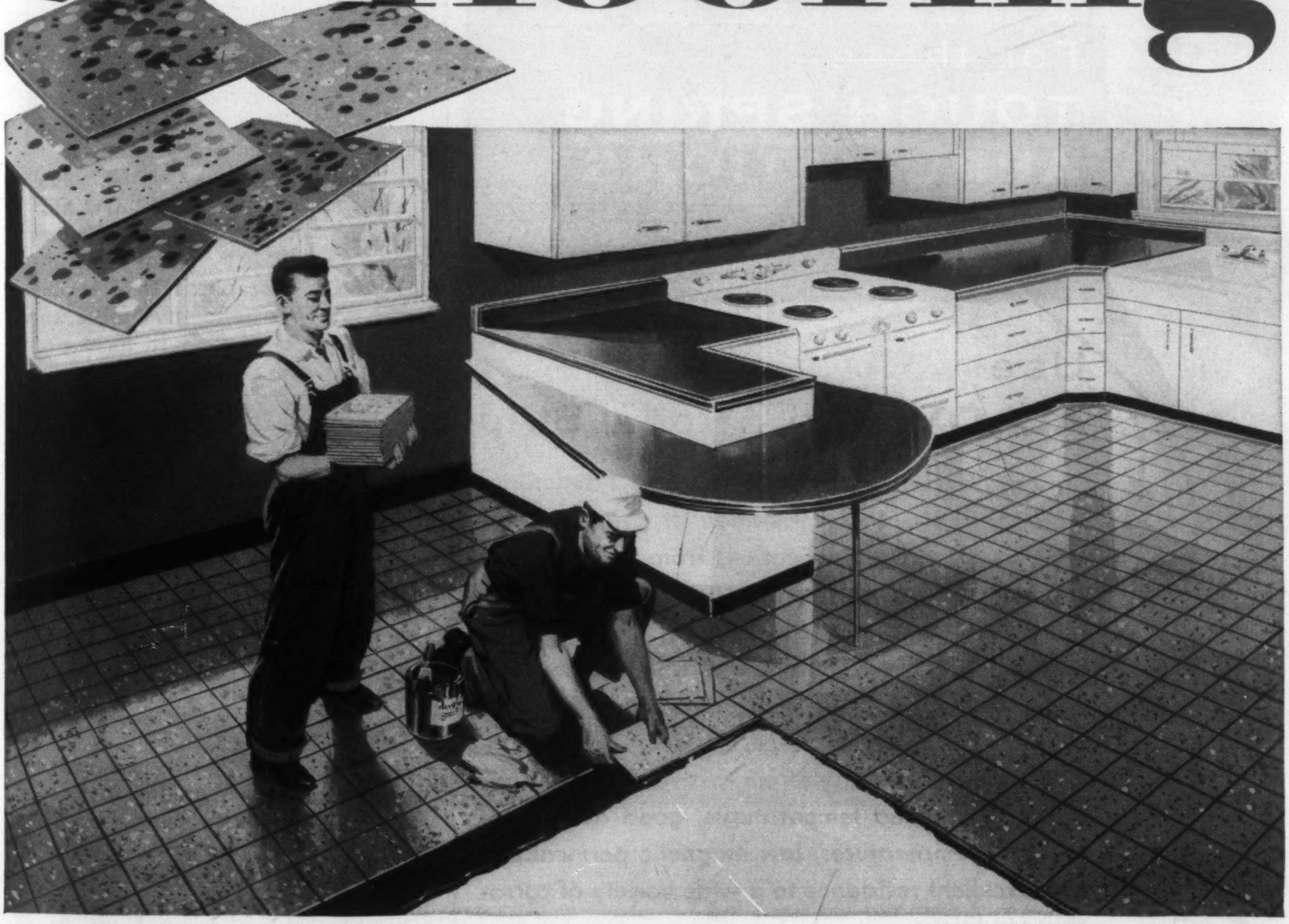
EXON: each resin engineered for a specific problem

Firestone
EXON
468

EXON 468

specifically for

flooring



Higher bulking density of EXON 468 increases the banbury output 10 to 25%! It makes processing easier, since it permits fast fusion at reduced temperatures.

A superior resin in every respect, EXON 468 offers good heat and light stability, high thermoplasticity, compatibility with conventional vinyl plasticizers, stabilizers and pigments.

Used as the base resin in vinyl asbestos floor tile formulations, EXON 468 provides new production economies — and superior end products.

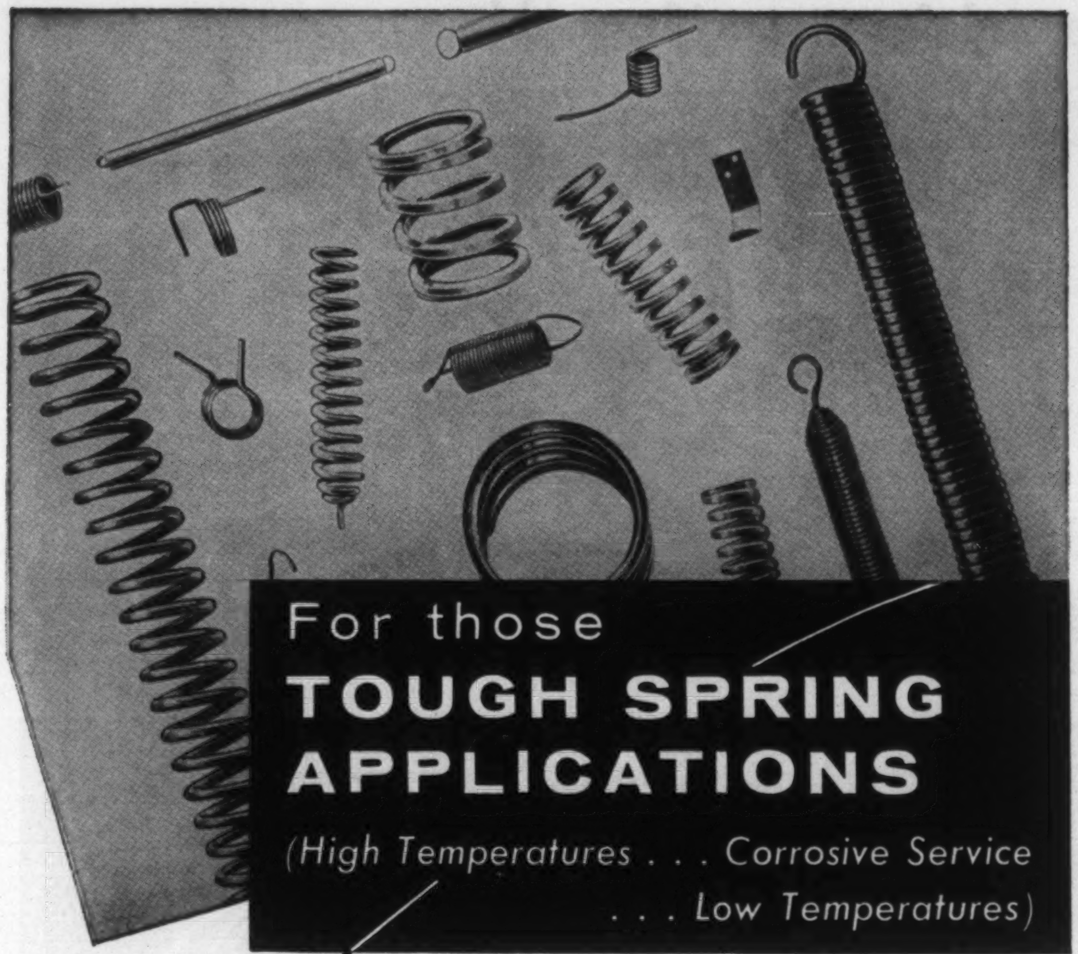
For suggestions on developing new products, or improving established ones with EXON 468—or for complete information or technical service on the growing line of versatile EXON resins, contact:

Firestone

EXON®

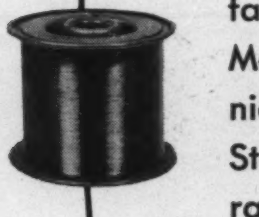
CHEMICAL SALES DIVISION
FIRESTONE PLASTICS COMPANY, POTTSTOWN, PA., DEPT. 63-B
DIVISION OF THE FIRESTONE TIRE & RUBBER COMPANY

For more information, turn to Reader Service Card, Circle No. 453



For those
TOUGH SPRING APPLICATIONS
(High Temperatures . . . Corrosive Service . . . Low Temperatures)

Use
ALLOY Wire . . . Rod . . . Strip



Spring Designers: You can readily select a material with just the right combination of properties for your tough spring applications from the alloys we fabricate into wire, rod and strip. Alloys such as Monel, K Monel, Inconel, Inconel X, Nickel, Duranickel, Austenitic, Ferritic and Martensitic Stainless Steels and special alloys are available in a wide range of tempers and special treatments. These materials feature high strength and fatigue properties at elevated temperatures, good ductility at sub-zero temperatures, low magnetic permeability and excellent resistance to a wide variety of corrosive conditions.

Alloy Metal Wire Division engineers will work closely with you to develop any special engineering and fabricating properties you may require. Your inquiries are always welcome.

Send today for our new Nickel Alloy and Stainless Steel Properties Charts.

ALLOY METAL WIRE DIVISION

HKP
H. K. PORTER COMPANY, INC.
Prospect Park, Pennsylvania

For more information, turn to Reader Service Card, Circle No. 405

New Materials, Parts, Finishes

the new resins are said to provide the following advantages: 1) Tukon hardness 50 to 100% greater (baking temperatures between 200 and 300 F); 2) gloss retention 150% better (after 16-hr exposure at 400 F); 3) whiteness retention 100% higher on Photovolt comparator (after 16-hr exposure at 400 F); and 4) substantially reduced blistering from prolonged immersion in hot solutions of household soaps.

Solvents such as xylol, toluol, high flash naphtha or butyl alcohol may be used, and enamels may be applied by spray or dip methods. Duraplex ND-76 is compatible with urea, melamine and triazine resins, and in most proportions with nitrocellulose, cellulose acetate butyrate and some silicone alkyds. In nitrocellulose lacquer formulations, it is said to give greater hardness than conventional alkyds, thus allowing use of more alkyd in the formulation, improving the outdoor durability of the lacquers.

Stretched Plastics for Glazing

Stretched transparent plastics sheets are now available for glazing applications requiring increased toughness and resistance to crazing, combined with reduction in weight. Resulting from a development of *Swedlow Plastics Co.*, Los Angeles, Calif., and Youngstown, Ohio, ⅜-in. stretched acrylic sheeting is being produced in sizes up to 48 by 48 in. Larger sizes up to 80 by 80 in. and in heavier thicknesses are expected. Also, according to the company, stretched polymethyl alphachloroacrylate will be available in the next few months. Swedlow has also developed techniques for forming and fabricating flat stretched sheets without significantly degrading the toughness of the material.

(More New Materials on p. 178)

Fill all your

COLD ROLLED SPECIALTY STEEL

needs at Crucible

You'll find, at Crucible, dozens of *prescription-made* cold rolled steels designed for special applications . . . steels for automotive stampings, business machine parts, saw blades, cutting dies, skates, springs and cutlery – to name just a few.

You'll find them in the widest possible variety – including carbon spring, alloy and stainless steels – in fact, in *any* ferrous analysis that can be cold rolled. And you're *sure* of *quality* at Crucible – the nation's leading producer of *special purpose steels* – for Crucible maintains *complete* control of production from ore to finished steel.

So when you need prompt delivery of *any* kind of cold rolled specialty steel *call Crucible*. Experienced Crucible metallurgists can help, too, in selecting the *best* steels for your job. And write for your free copy of Crucible's new 32-page booklet on cold rolled specialty steels. It's packed with useful data. *Crucible Steel Company of America, Henry W. Oliver Building, Pittsburgh 30, Pa.*

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

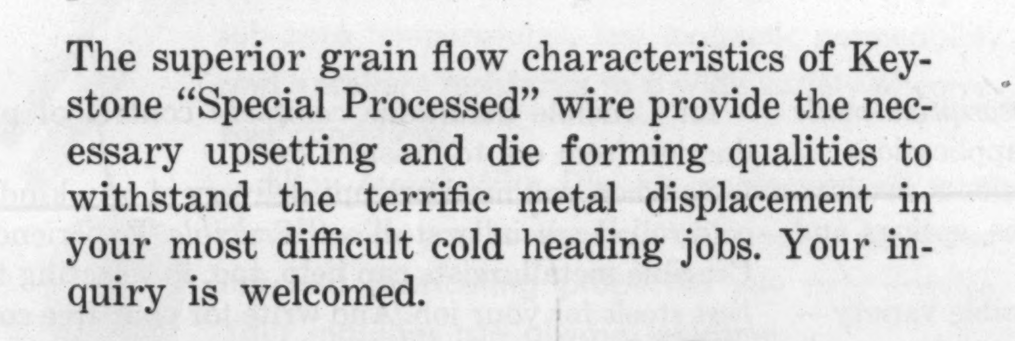
*For more information, turn to Reader Service Card, Circle No. 326

FROM THIS
TO THIS
...at Lower Cost per Unit with
KEYSTONE
"SPECIAL PROCESSED"
COLD HEADING WIRE

Due to the unusual deep socket in the above Adjusting Screw it could not be formed from regular annealed and processed cold heading wire.

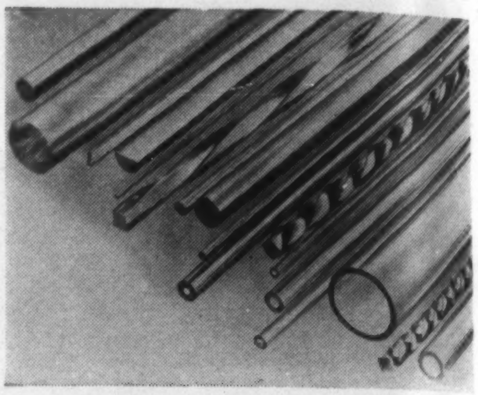
Keystone's metallurgist recommended Keystone "Special Processed" wire. The manufacturer has now standardized on "Special Processed" wire for this and other difficult cold headed parts. His results have been improved quality, increased production and lower cost per unit.

The superior grain flow characteristics of Keystone "Special Processed" wire provide the necessary upsetting and die forming qualities to withstand the terrific metal displacement in your most difficult cold heading jobs. Your inquiry is welcomed.



For more information, turn to Reader Service Card, Circle No. 364

New Materials, Parts, Finishes



Clear Extruded Rod and Tubing

Clear methyl methacrylate rods, tubing and shapes for a variety of uses are being marketed by *Ace Plastic Co.*, 91-36 Van Wyck Expressway, Jamaica 35, N. Y. Made of Rohm & Haas' Plexiglas and du Pont's Lucite, the materials are available from stock in many sizes or in special sizes to order. Rods 1/8 through 3/4 in. in dia are available in 6-ft lengths, and 7/8 through 1 1/4 in. in dia are available in 4-ft lengths. Tubes are produced in 6-ft lengths with tolerances of ±0.010 in. up to 7/8 in. dia, and ±0.015 in. on 1 in. dia and over.

Corrosion Resistant Paint Base

A solid chlorinated rubber-based resin, said to be non-toxic, non-flammable, tasteless and odorless, has been developed for use as a base for paints. The dry powder needs only be dissolved and pigment added. It contains no oil or other saponifiable matter and is supplied fully plasticized and stabilized. Developed by *All-weather Paints, Ltd.*, 36 Great Queen St., London, W. C. 2, England, the material contains special wetting and dispersing aids. When converted into paint, resulting films have good resistance to acids, alkalis and brine. It forms a film which is said to be hard yet flexible.

Contents Noted

A digest of papers, articles, reports and books of current interest.

This Month:

- *Polyethylene's permeability*
- *High temperature alloys*
- *Titanium heat treatment*
- *Radiation curing of rubber*
- *Tempering martensitic stainless*

Permeability of Polyethylene

Due to its corrosion resistance and other favorable characteristics, polyethylene has been assuming an ever-increasing importance as container material for chemicals. One of its major drawbacks for this use, however, is its permeability to certain types of chemicals. It is more or less permeable at room temperature to all volatile materials, the degree of permeability depending on the type of material. For a given substance, permeability is a function of temperature and is proportional to contact surface. It is also inversely proportional to thickness of polyethylene, provided evaporated substances are continuously removed so equilibrium is not reached.

These conclusions are incorporated in an article in the September issue of *Materie Plastiche* (Italian) by F. Ranalli, which details results of studies of permeability of polyethylene to a large variety of materials. It might be of interest here to mention that two concerns in the U.S. recently announced the availability of polyethylene containers incorporating thin impermeable film linings. The containers are designed particularly for containing volatile materials to which polyethylene is permeable.

Permeability data

The accompanying table lists rate of transmission of various chemicals through an 0.04 in. thick polyethylene sheet. Chemically pure substances show a constant rate of evaporation unchanged by test time. Impure substances, such as some of the essential oils, do not. Mixtures of pure chemicals and such essences show a variable rate since the more volatile materials evaporate more rapidly at first, changing the composition of the material remaining in the container.

Calculations for loss in 1 yr from 500 cc container (see table) indicate commercial limits for use of polyethylene containers. Undoubtedly they would be suitable for materials in the table from water to 95% ethyl alcohol. Loss of essential oils used in perfumes is such as to make polyethylene a questionable receptacle. Perhaps it might be suitable for less volatile oils. For mixtures of alcohol and essential oils, permeability to the two components is not the same, so the mixture remaining in the container will change in composition, and therefore, degree of permeability will change with time.

In some cases high permeability is advantageous. For instance, in moth-proofing, a slow constant evaporation of the naphthalene or paradichlorobenzol is desirable. Or in conserving vegetables, the proper humidity must be maintained as well as rapid removal of oxygen and carbon dioxide. The aroma of tobacco is also well preserved by polyethylene sheet.

(More Contents Noted on p. 182)

TRANSMISSION OF CHEMICAL SUBSTANCES THROUGH POLYETHYLENE SHEET
(At 22 ±0.2 C with Continuous Removal of Transmitted Vapor)

	Through 0.04 in. sheet, g/24 hr/m²	Loss in One Year[1], % of original wt
Water	0.081	0.25
Menthol	0.127	0.44
Camphor	0.194	0.60
95% Ethyl alcohol	0.334	1.3
Coriander essence	0.370	1.3
27% Aqueous solution of NH_3	1.07	3.6
Naphthalene	1.34	3.7
Bergamot essence	1.46	5.0
Acetic acid	1.62	5.0
Benzoic aldehyde	2.96	8.6
Acetone	4.75	18.2
Methyl-ethyl-ketone	6.40	24.4
Oil of turpentine	6.86	24.4
n-Butyl acetate	8.06	28.0
P.Dichlorobenzol	11.4	25.0
Dichloroethane	33.7	82.0
Benzene	141.0	100.0 within 65 days
Ethyl ether	163.0	100.0 within 52 days
Benzol	176.0	100.0 within 60 days
Xylol	187.0	100.0 within 54 days
Toluol	222.0	100.0 within 48 days
Carbon tetrachloride	260.0	100.0 within 73 days

[1] *Cylindrical 500-cc flask with 0.04 in. wall thickness initially completely filled with substance being tested.*

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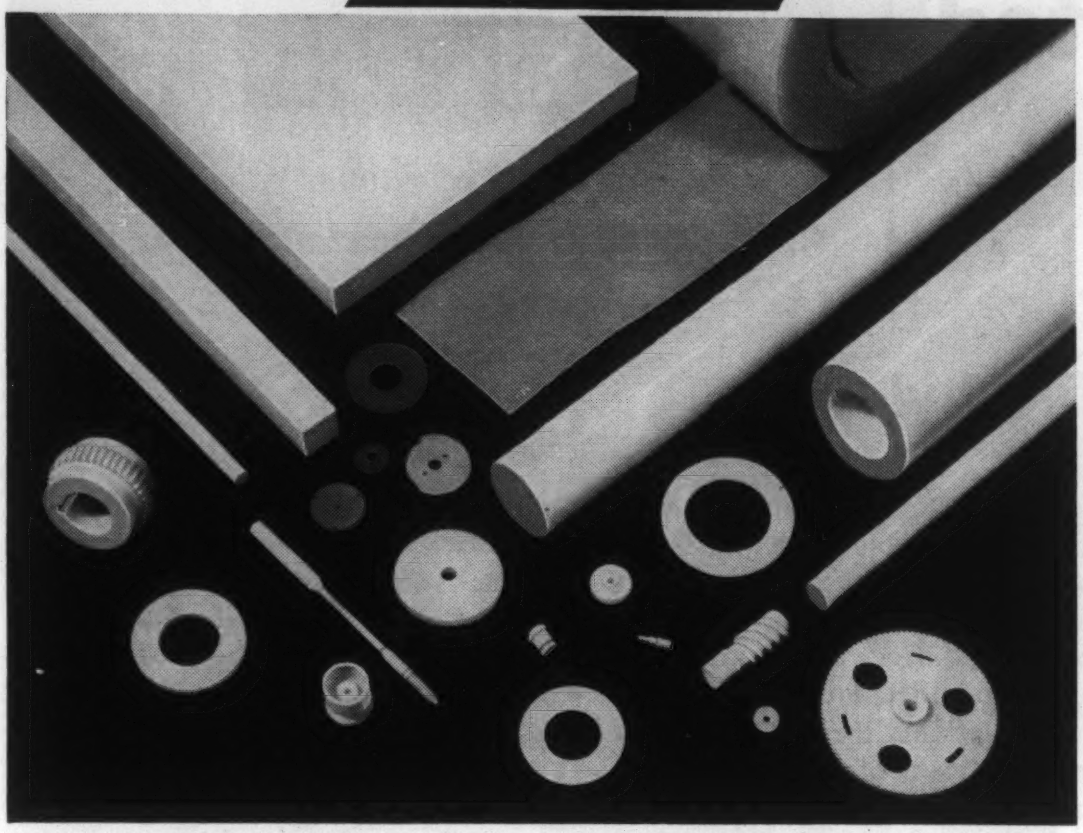

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*DU PONT TRADEMARK

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Contents Noted

Selecting High Temperature Alloys

Though a great deal has been written in this country about selecting high temperature alloys, it is interesting to note the approach taken by engineers and designers of other countries. In the July/August issue of *Métaux* (French), L. Colombier discusses these so-called "refractory" steels and alloys in the light of their resistance to oxidation and other media.

Oxidation resistance

Though chromium, silicon and aluminum all increase resistance of other metals to oxidation, all alloys used commercially contain chromium, augmented in some cases by silicon and aluminum. Oxidation resistance of the chromium-iron alloys increases with

PRELIMINARY GUIDE TO CHOICE OF HIGH TEMPERATURE ALLOYS

Service Temp, F	Materials
SERVICE IN OXIDIZING ATMOSPHERE	
1200	5-6% Cr steel[1]
1560	17% Cr steel[1]
1650	18-8 austenitic steel and its various modifications
2010	28% Cr steel,[2] 25-12 and 25-20 austenitic steels, 35% Ni alloys
2100	60 and 80% Ni alloys
SERVICE IN CARBURIZING ATMOSPHERES	
1650	25-12 and 25-20 austenitic steels
1830	35% Ni alloy
2010	60 and 80% Ni alloys
SERVICE IN REDUCING ATMOSPHERE CONTAINING SULFUR	
1290	18-8 austenitic steel
1380	17% Cr steel[2]
1650	25-12 and 25-20 austenitic steels
1830 –	28% Cr steel[2]

[1] *Welding difficult.*
[2] *Welding to be avoided.*

Norton Products For The Atomic Program

Over half a century ago Norton Company first used electric furnace techniques to produce fusion-stabilized materials. Through the years Norton fusion-stabilized materials such as fused alumina, silicon and boron carbides, fused magnesia, zirconia, etc., have been made more valuable to industry and have been raised to new standards of quality, uniformity, and purity.

Today, Norton keeps pace with the greatly increased demands of the atomic age for new high melting, chemically stable materials. In Cleveland in December, at the Atomic Exposition, a Norton exhibit will feature fusion-stabilized products and other products which have shown important potentialities for atomic energy applications:

Reactor Components

Stable boron compounds for reactor control elements and neutron shields. Ceramic and powder-metal fabricated components for fuel element applications.

Special Refractories

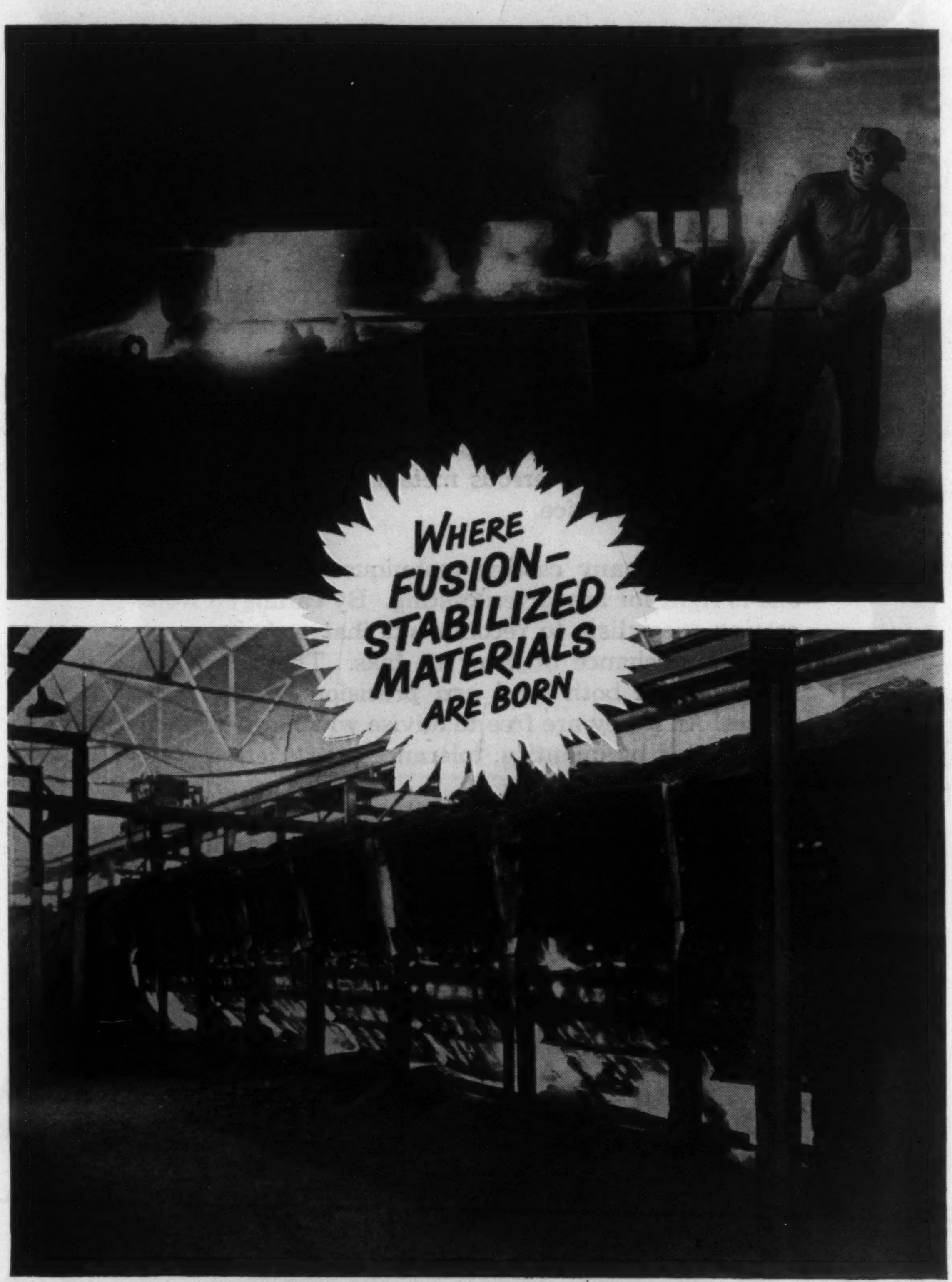
High-purity ceramic shapes, including crucibles and furnace components for processing metals and fuel elements.

Raw Materials

High-purity oxide, carbide, boride and nitride materials in granular and powdered form.

In addition, Norton is presently developing numerous experimental items. The Norton research and development organization includes an engineering staff experienced in atomic development — available for cooperation where electric furnace products may be of interest.

Norton high-melting materials have varied applications in many fields. In particular, they are the basic ingredients of the famous Norton Refractory ℞'s — refractories *engineered and prescribed* for the widest range of industrial uses. For further information write, mentioning your requirements, to NORTON COMPANY, Refractories Division, 354 New Bond Street, Worcester 6, Massachusetts.



Above: Norton arc-type furnaces. *Below:* Norton resistance-type furnace.

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Contents Noted

chromium content and may be further improved by small additions of aluminum or silicon. The commercially popular alloys range from the 5-6% chromium, extensively used in petroleum refineries and synthetic fuel plants, to the 25-30% chromium, which are used extensively despite their mediocre mechanical and fabricating characteristics and their susceptibility to embrittlement.

Chromium-aluminum-iron alloys with 5-30% chromium and 0.6-5% aluminum have many disadvantages from the standpoint of fragility and low hot strength, but are preferred in many cases to nickel-base alloys because of their superior resistance to sulfur-bearing atmospheres and higher permissible service temperatures.

In the chromium-nickel series, maximum oxidation resistance is found at about 50% nickel, but fabrication difficulties have made a 20% chromium alloy most popular. In practice the chromium-nickel-iron alloys are most commonly used. These extend from the simple 18-8 to 15-60 alloys. The accompanying tables are offered as a guide to selection of most suitable materials for specific service conditions.

Resistance to other media

Though these alloys were originally developed for their oxidation resistance, actual service conditions may involve other media. Since the rapid combination of nitrogen with chromium is slowed down by nickel, austenitic chromium-nickel alloys with high nickel contents are preferred for service in non-oxidizing nitrogen atmospheres. At low hydrogen pressures, any of the alloys may be used up to 2010-2190 F, according to Colombier. At higher pressures, however, it is a different story. Though a 6% chromium steel (usually containing molybdenum) can be used up to 300 atmospheres with moderate temperatures, austenitic steels are resistant to all pressures and thus they resolve the problems which are raised by hydrogen.

Effect of sulfur depends on

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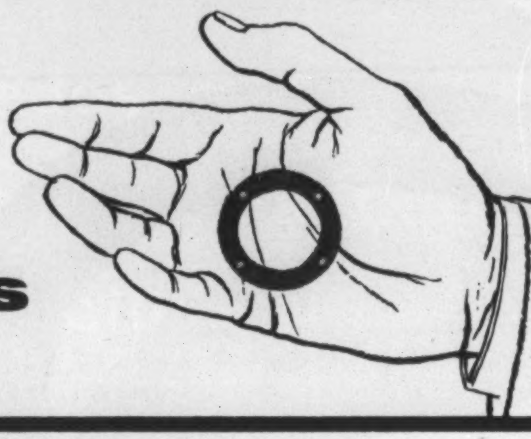

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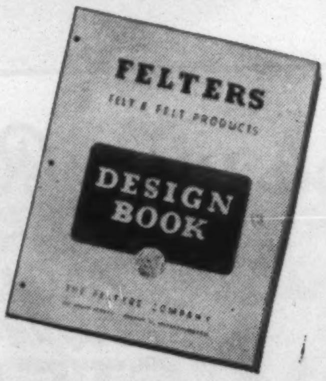

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Contents Noted

whether it is present as SO_2 or as the more agressive H_2S. Resistance of all alloys to H_2S is less than it is under oxidizing conditions. Nickel is deleterious in sulfur-bearing atmospheres above about 1300 F. Even chromium steels are not always adequate at extremely high temperatures, and the best resistance is obtained when aluminum or silicon is also present. Extremely varied conditions are posed by salts, molten metals and products of combustion. Any solid material in contact with the alloys may decrease their resistance.

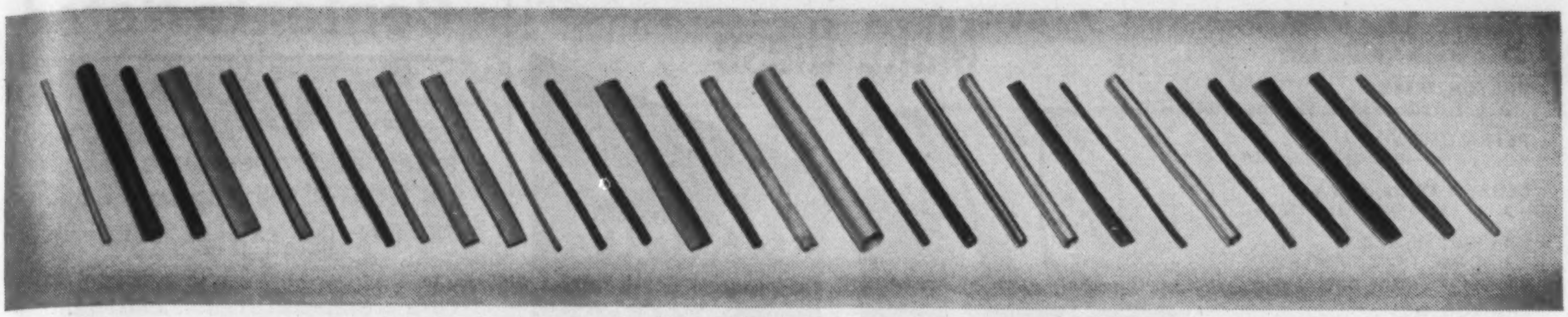
The author summarizes by pointing out that resistance to attack by surrounding media is not the only problem. Among the various available materials that resist a certain medium, choice must be made on the basis of fabricating and joining characteristics and strength at temperature. Consequently, the number of "refractory" metals and alloys used commercially remains relatively small.

Heat Treatment of a Titanium Alloy

One of the most popular commercial titanium alloys, 6 aluminum-4% vanadium, developed by Armour Research Foundation is moderately heat treatable. In ½-in. sections, tensile strengths from 130,000 to 175,000 psi and yield strengths from 100,000 to 165,000 psi can be obtained while maintaining high ductility. In a paper presented before the Annual Convention of the American Society for Metals last October, R. G. Sherman and H. D. Kessler summarized results of work done by Titanium Metals Corp. of America to determine heat treating characteristics of the alloy. Special emphasis was placed on solid solution plus age heat treatments.

Results summarized

Tensile and yield strengths in the range mentioned above can be obtained using solution treatments from 1550 to 1750 F and



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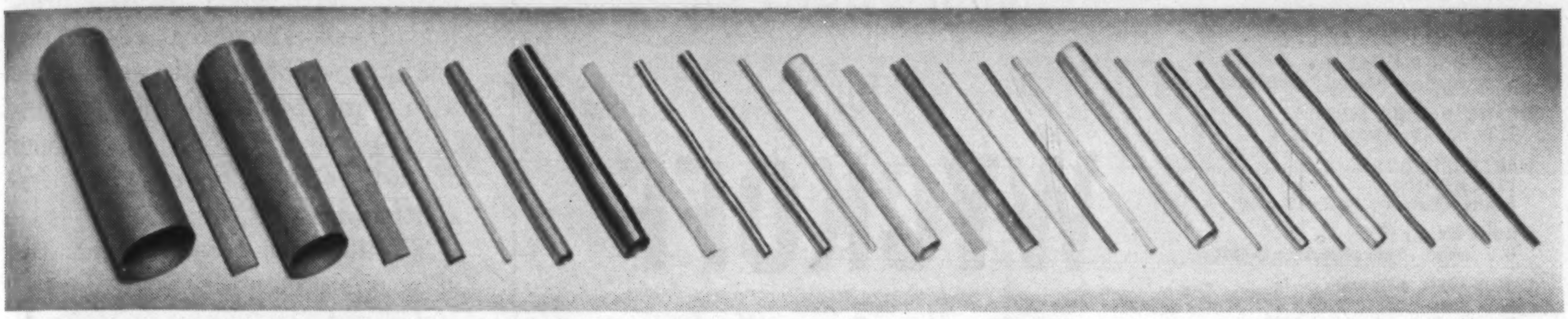

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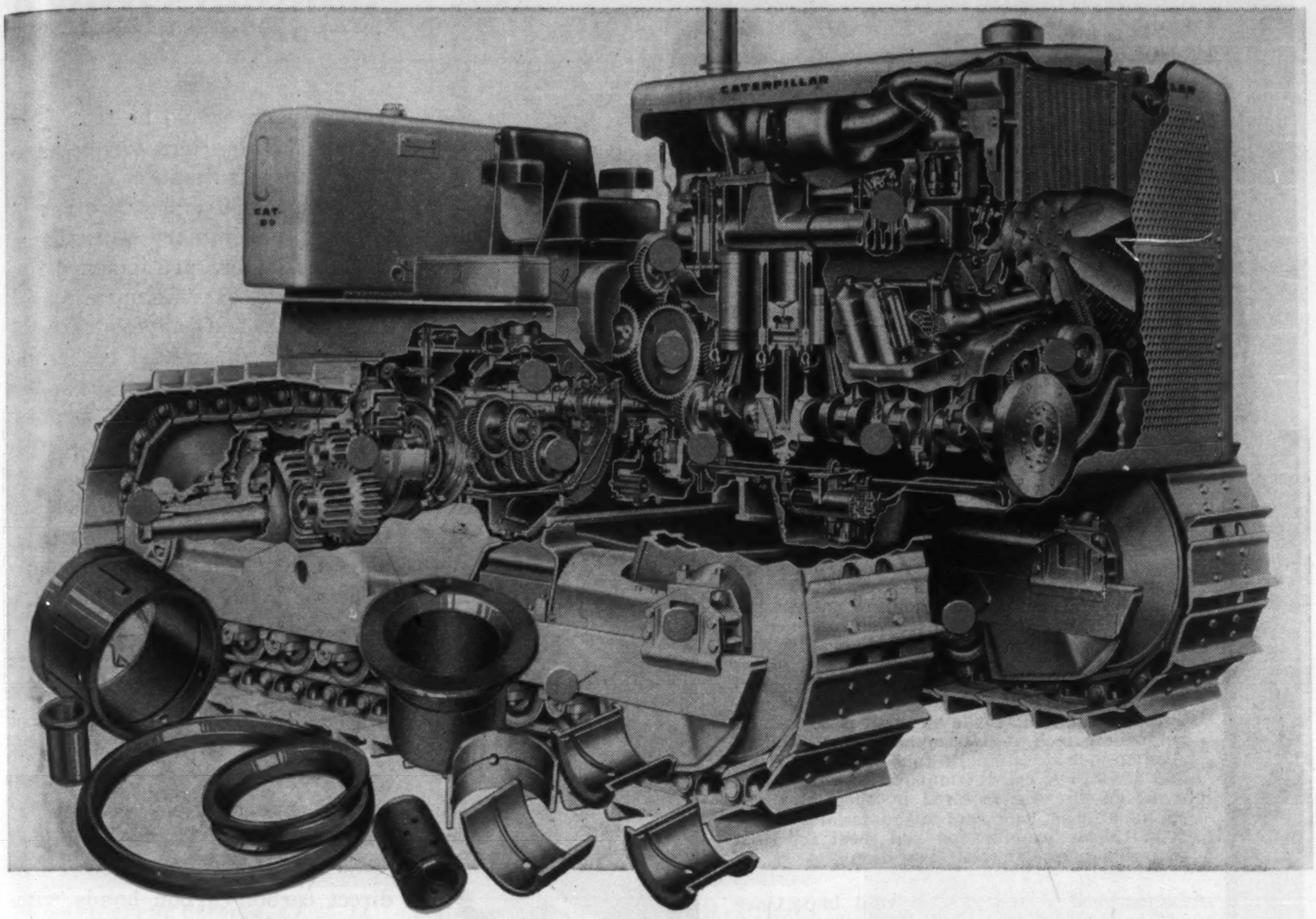
aging at temperatures from 900 to 1000 F. Strengths as low as 130,000 psi can be obtained by very slow cooling from the solution temperatures. The 1550 F solution treatment results in the lowest yield-tensile ratio and offers possible advantages of good machinability and excellent low temperature formability. Subsequent aging can then be used to increase strength to maximum levels. With good forging practice, yield strengths of 130,000 psi can be obtained in sections to 3 in.; and 140,000 psi in sections to 1½ in., with ductility values of 20% elongation and 50% reduction in area.

The authors point out that the alloy is stable under conditions of 50,000 psi for 200 hr at temperatures to 800 F. Total deformation of less than 1% under these conditions may be achieved by use of a 1750 F treatment for 1 hr, followed by water quench and 24 hr treatment at 1000 F. Under these conditions the alloy has an 800 F tensile strength of 115,000 psi and yield strength of 97,000 psi. Fatigue endurance ratio of the alloy is greater than 0.55 for heat treatments evaluated.

Possibilities of Irradiated Rubber

Vulcanization of rubber by gamma rays is a new process which must compete with chemical vulcanization processes which have undergone a hundred years of intensive development. Although relatively little is known about it as yet, the irradiation method seems to have definite advantages. These include developing new types of rubber which cannot be readily vulcanized by chemical systems. This chemical inertness could be reflected in superior aging stability and resistance to high temperatures. Cold gamma ray vulcanization should also permit vulcanization of extruded or preformed shapes without distortions which occur during heating, and metal-bonded



Dependable Johnson Bearings Help Give Long Life To Big Cat Machinery

Engine bearings and bearings in track rollers and other components play a big role in the ability of Caterpillar Diesel Tractors to give long, satisfactory performance on tough jobs.

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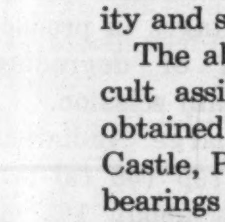
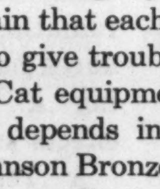
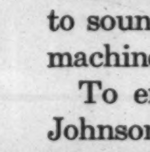
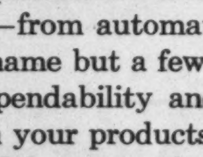
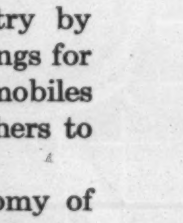
Johnson Bearings

LEDALOYL (powder metallurgy) • **ALUMINUM ON STEEL** • **BRONZE ON STEEL** • **STEEL AND BABBITT** • **CAST BRONZE**

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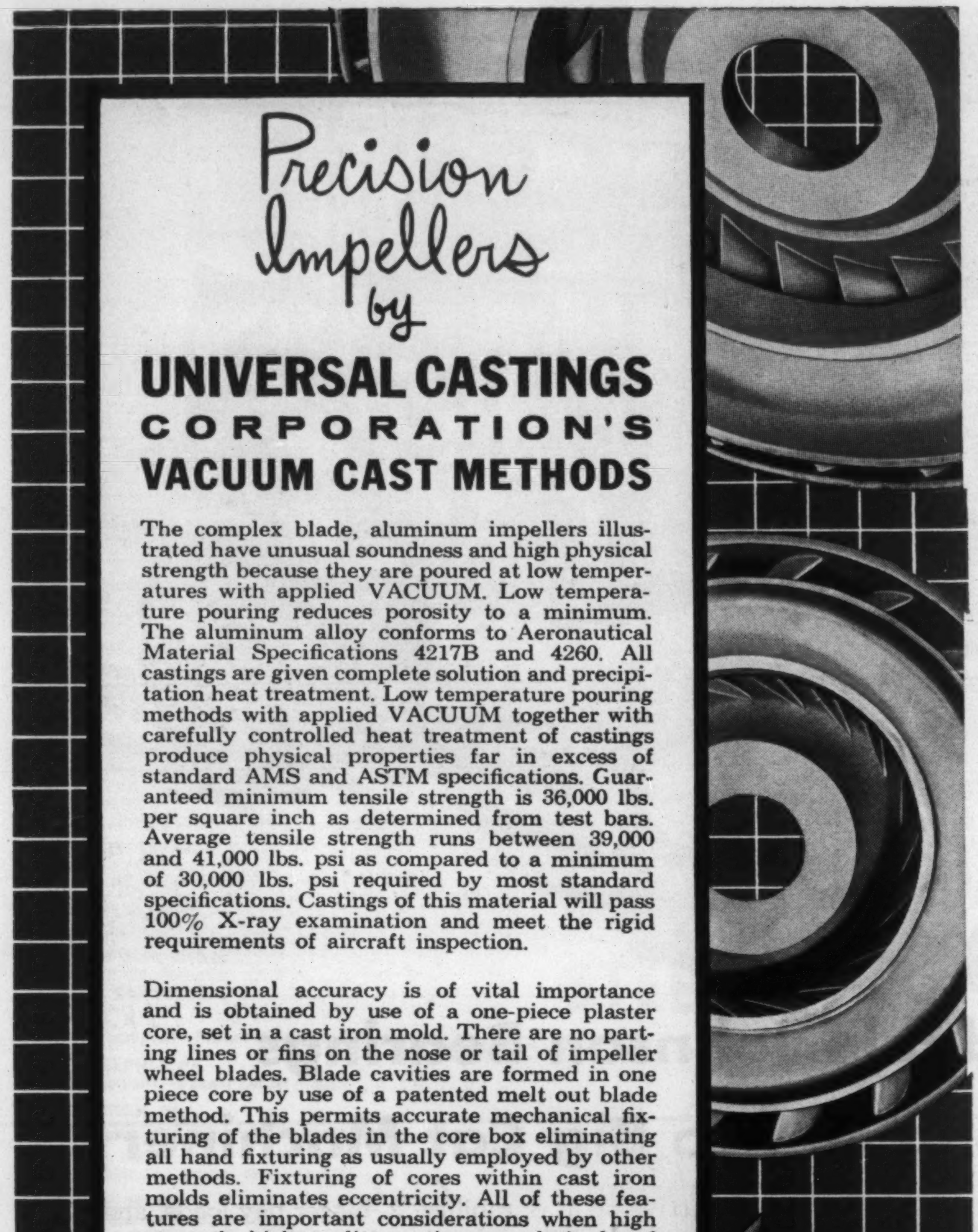

Precision Impellers by

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The complex blade, aluminum impellers illustrated have unusual soundness and high physical strength because they are poured at low temperatures with applied VACUUM. Low temperature pouring reduces porosity to a minimum. The aluminum alloy conforms to Aeronautical Material Specifications 4217B and 4260. All castings are given complete solution and precipitation heat treatment. Low temperature pouring methods with applied VACUUM together with carefully controlled heat treatment of castings produce physical properties far in excess of standard AMS and ASTM specifications. Guaranteed minimum tensile strength is 36,000 lbs. per square inch as determined from test bars. Average tensile strength runs between 39,000 and 41,000 lbs. psi as compared to a minimum of 30,000 lbs. psi required by most standard specifications. Castings of this material will pass 100% X-ray examination and meet the rigid requirements of aircraft inspection.

Dimensional accuracy is of vital importance and is obtained by use of a one-piece plaster core, set in a cast iron mold. There are no parting lines or fins on the nose or tail of impeller wheel blades. Blade cavities are formed in one piece core by use of a patented melt out blade method. This permits accurate mechanical fixturing of the blades in the core box eliminating all hand fixturing as usually employed by other methods. Fixturing of cores within cast iron molds eliminates eccentricity. All of these features are important considerations when high strength, high quality castings are desired and are only obtainable through low temperature VACUUM pouring of metals.

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rubber parts would be free of internal stresses due to shrinkage after vulcanization.

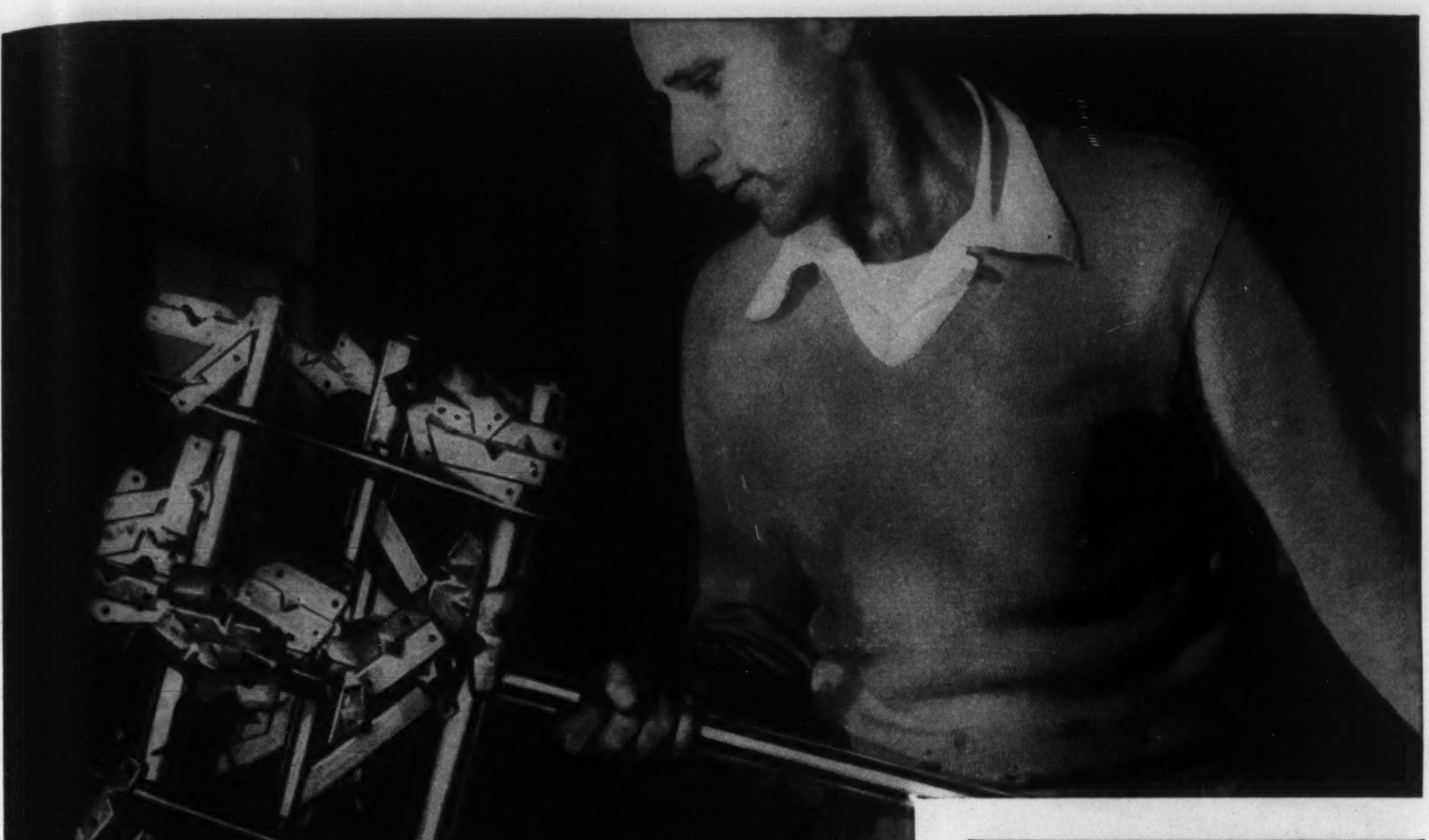
These conclusions and other results of preliminary work on irradiated rubber are included in a paper by S. D. Gehman and I. Auerbach of Goodyear Tire & Rubber Co., presented before the Atomic Industrial Forum in Washington, D. C., last September. The authors point out that gamma rays cross-link rubber by the same mechanisms as occur on irradiation of plastics such as polyethylene, though the efficiency is not as great as with plastics.

Cross-linking

Not all plastics and polymers cross-link under irradiation. Some such as butyl rubber, degrade or break down. Whether they degrade or cross-link depends on the chemical structure of the chain molecules. The cross-linking of rubber by irradiation can be direct carbon-carbon bonds without the sulfur. Vulcanizates thus formed will be inherently more stable than sulfur vulcanizates since the energy of the C-C bond is 58.6 as compared with 27.5 k cal/mole for polysulfide bonds. Smearing temperatures for gamma ray vulcanizates of rubber and carbon black are about 500 F versus 400 F for ordinary vulcanizates. There also seems to be evidence to the effect that certain radiations or irradiation procedures have advantages in producing a minimum of degrading effects such as chain scission.

A relatively large radiation dose of 3 x 10^7 rep (66 cal per gram) cross-links about 1% of the monomer units in rubber. This energy will raise the temperature of a gram of rubber about 238 F if there are no heat losses. Thus, energy input is comparable to thermal input required for chemical vulcanization. Of course, temperature rise during irradiation will be determined by rate at which dose is delivered and heat losses.

The addition of the usual chemical vulcanizing agents or fluorescing materials seems to have



9½ Pound Magnetic Octopus, about 12" square, primarily designed for dip tank use in hot or corrosive liquids, as shown. Utilizing Alnico magnets in 3 small stainless steel (18-8) tubes, it retrieves tools, tramp iron and tiny iron particles from hard-to-reach bottoms of ovens, troughs, tanks and other vessels.

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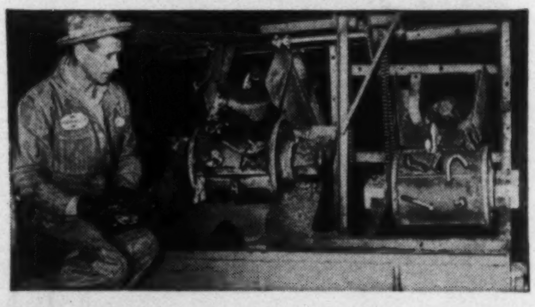
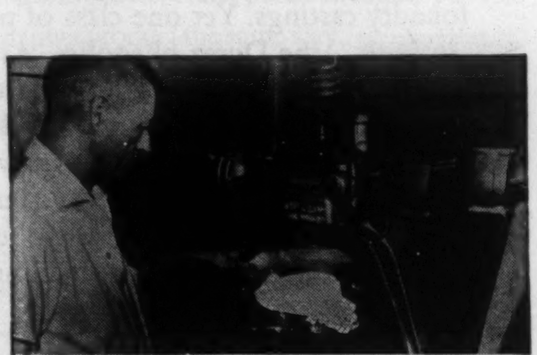


Better Product Assured where Eriez permanent magnetic drums remove stray iron from tallow and meat scraps.

Safeguards Hammer Mill. Eriez non-electric magnetic pulley removes tramp iron from wood chips on belt feeding the mill and explosive mixtures beyond.



Cleans Powdered Chemicals. Eriez permanent magnetic grate removes invisible iron particles from drugs and the like.

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little effect on gamma ray vulcanization. However, it is possible that agents will eventually be found which will permit reduction in the radiation dose required.

Tensile strength of vulcanizates

Gamma ray vulcanization seems to produce natural rubbers with lower tensile strengths than those produced by chemical vulcanization. Strengths on the order of 1900 psi, as compared with 3500-3900 psi for chemical vulcanizates have been obtained. The authors point out that though tensile strength is frequently regarded as a measure of quality for rubber, it should be kept in mind that rubber is not usually used in tension, and tensile strength does not enter directly into serviceability of the rubber. It is possible that initial lower tensile strength would be offset by superior retention of properties due to absence of sulfur and other reactive chemicals.

When experimenting with GR-S, gamma ray vulcanization did not overcome the inherent structural weakness of GR-S gum stocks. Addition of carbon black is still required for good tensile strength. Fillers have more effect on results with gamma ray vulcanization than do usual rubber chemicals. Good results were obtained with mixtures of rubber and carbon black with tensils well over 2000 psi for a dose of 10^7 rep. The authors conclude that there may be an optimum relation between filler, loading and radiation dose.

If the large radiation dose necessary to vulcanize is taken over a short period of time, the temperature may rise to ordinary vulcanizing temperatures of 275-300 F. This suggests that a combination of cross-linking due to radiation and some chemical vulcanization might provide a most efficient system for using radiation. Furthermore, heat should be sufficient to permit molding the rubber. One of the advantages of gamma ray vulcanization would be that thick rubber articles, even up to a foot or more thick could

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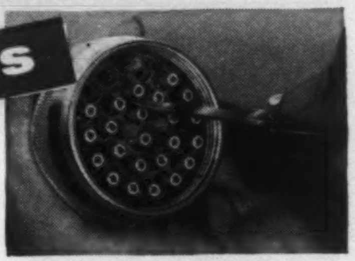

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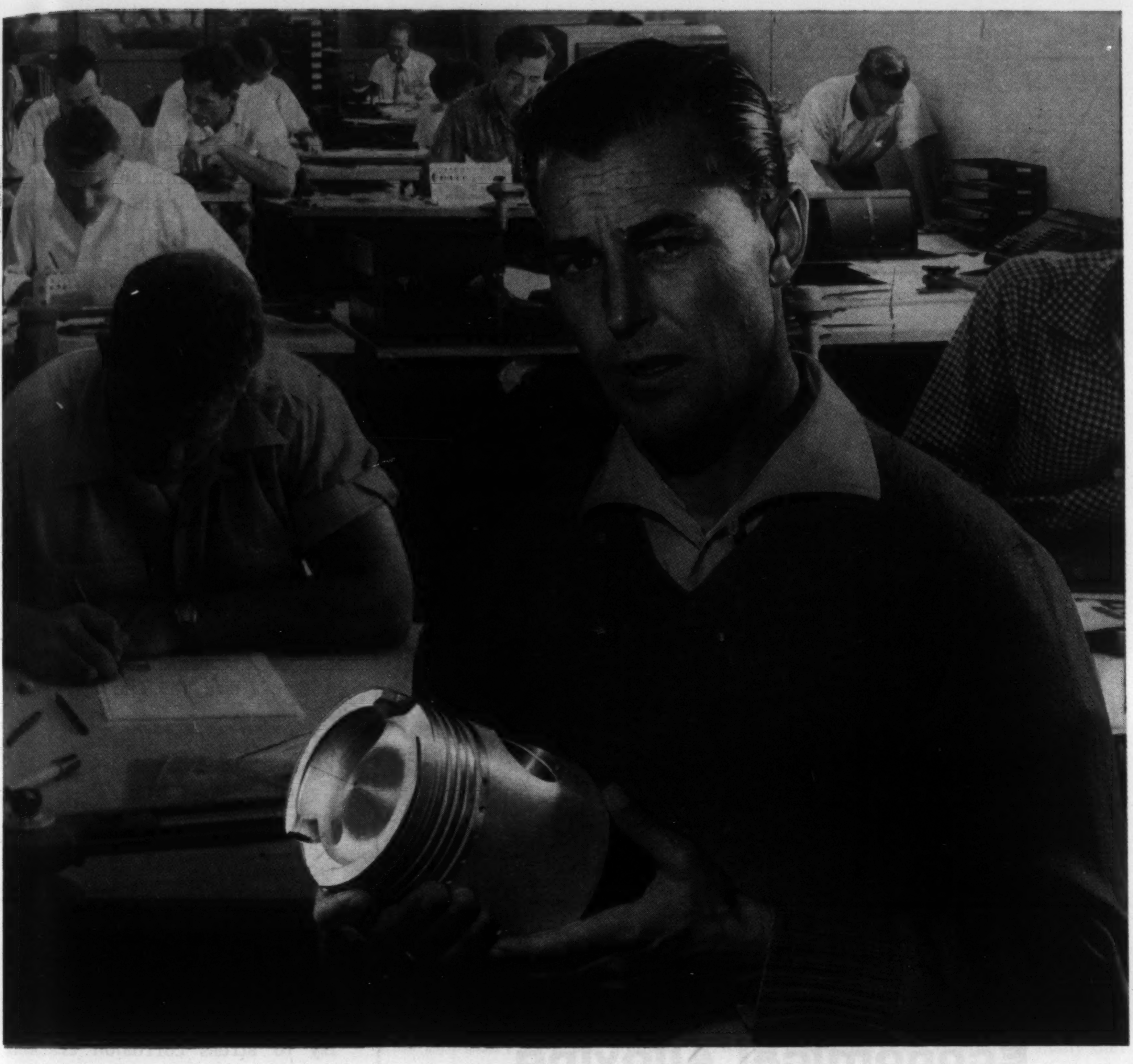

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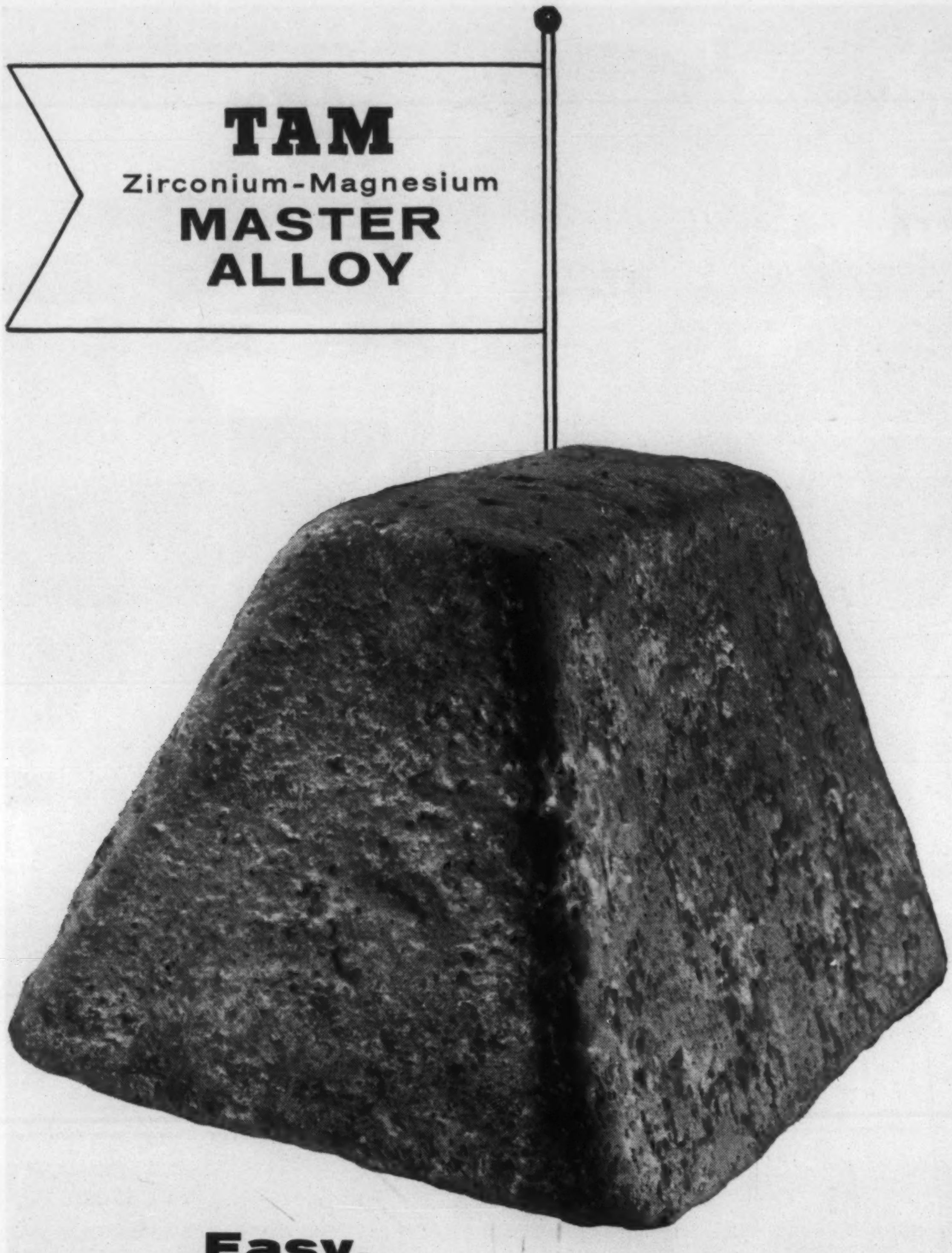

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be vulcanized uniformly and as rapidly as a thin sheet. For example, with conventional thermal conductivity heat flow, with surfaces at 250 F, it would take about 35 hr to vulcanize a one foot thick rubber press pad.

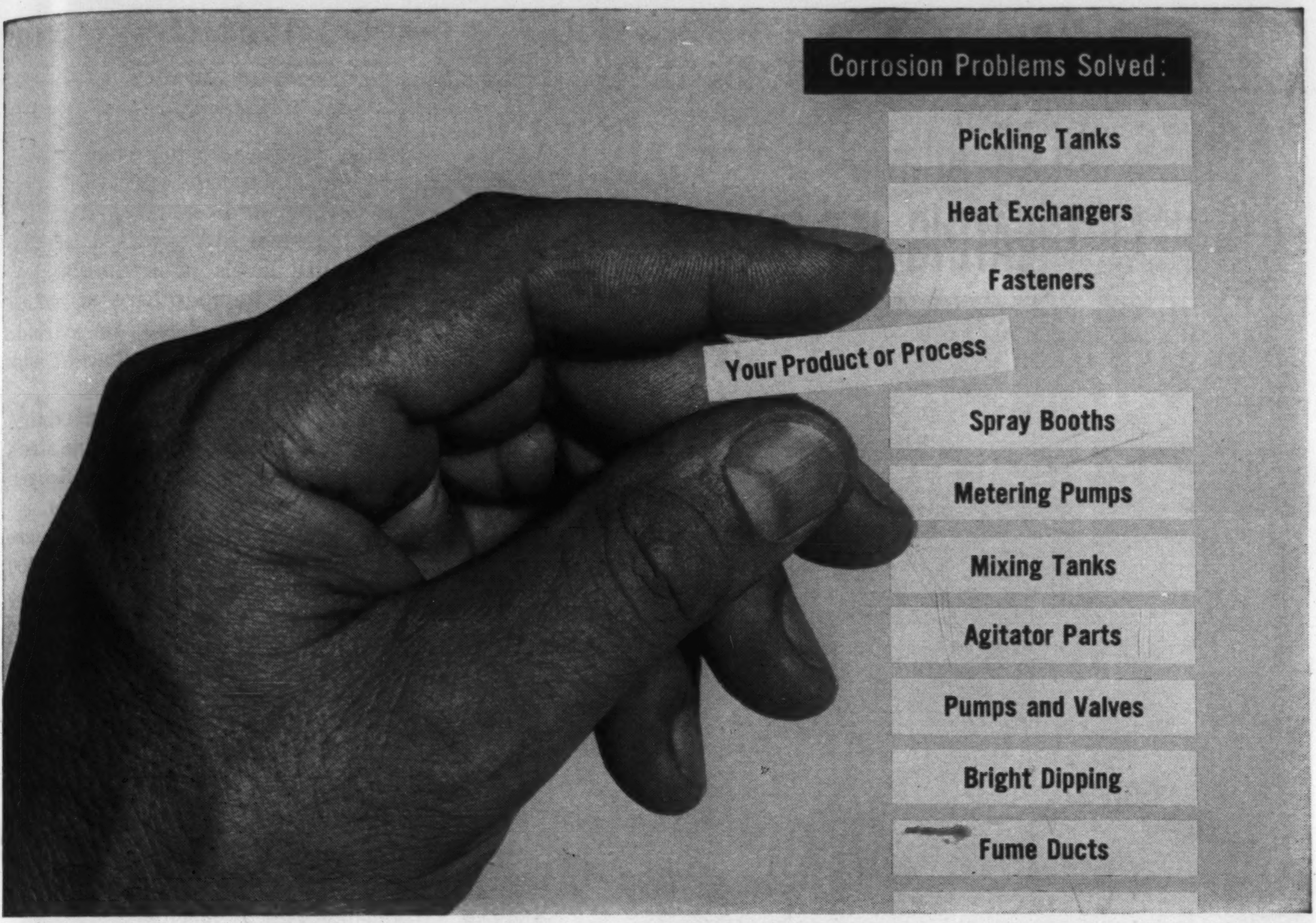
Corrosion and Embrittlement of Martensitic Stainless

Tempering temperatures have a definite effect on susceptibility of martensitic stainless steels to stress corrosion cracking, and failure due to hydrogen embrittlement. Data have been gathered on the susceptibility of Types 410, 420, 422 and 436 alloys tempered at various temperatures in the range of 300 to 1200 F. These data are incorporated in a paper by P. Lillys and A. E. Nehrenberg of Crucible Steel Co. presented before the Annual Convention of the American Society for Metals last October. Results indicate that a temper at about 500 F provides minimum susceptibility to cracking by hydrogen embrittlement for high levels of hardness. Maximum susceptibility to stress corrosion cracking and hydrogen embrittlement results from a temper at about 800-1000 F.

Tests and results

Specimens were stressed by bending to a stress level generally well below the elastic limit and were subjected to stress corrosion studies in an atmosphere of 5% sodium chloride. Delta ferrite was found to minimize tendency for stress corrosion cracking by narrowing the range of tempering temperatures which produce cracking susceptibility, and by interfering with crack propagation.

Times for failure by hydrogen embrittlement vary with tempering temperature in the same manner as impact values vary with tempering temperature in these steels. Variations in susceptibility to failure seem to bear a defi-



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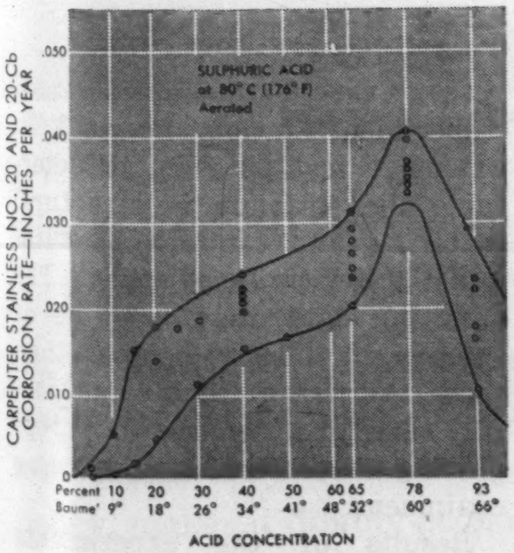

Carpenter Stainless No. 20-Cb is available from The Carpenter Steel Company, Alloy Tube Division, Union, New Jersey, in the forms of tubing, pipe, sheet, plate and strip; and Stainless No. 20 in the forms of bars, strip, wire and billets. In addition, many other No. 20 fabricated parts are available from various manufacturers. Write us for their names.

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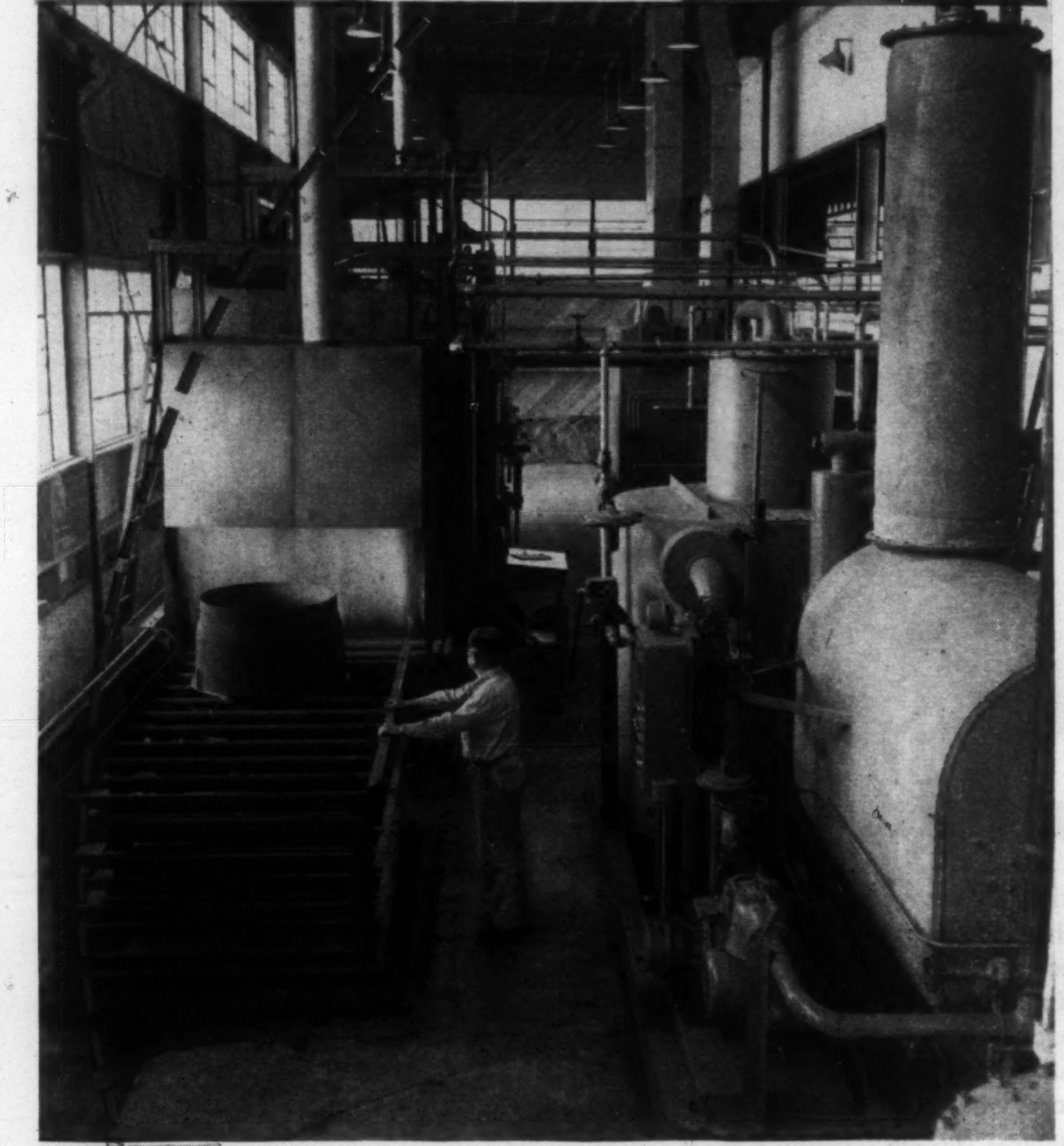

"We can certainly say this: 'We are very happy with the Gas Atmospheres' unit.'" This from an executive of the Solar Aircraft Co., San Diego, in reference to a Gas Atmospheres' 8000 cfh low ratio nitrogen gas generator that furnished the nitrogen for one of the largest controlled atmosphere furnaces west of the Mississippi.

Heat treating housing bodies and other parts for the Wright J65 jet engine. Solar engineers are particularly impressed with the versatility of the unit. They have operated it with gas-air ratios as low as 5.5-1 and as high as 9-1 with consistent gas composition at all ranges. "The unit operates continuously with a minimum of maintenance, and its simplicity makes training personnel an easy matter," they state

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nite relationship to various stages in the tempering process. Tendency for hydrogen embrittlement in the steel heat treated to high strength levels is a minimum at about the temperature at which an incoherent chromium carbide begins to form at the parent austenite grain boundaries.

The investigation indicated that the 12% chromium stainless steels can be made to fail by hydrogen embrittlement, as has been reported previously, when they are tempered at temperatures of 1000 F or under. Failures were also obtained by exposing the steels to a 5% sodium chloride atmosphere. These latter failures were considered to be stress corrosion failures. During tempering, chemical inhomogeneities are developed along crystallographic planes and at parent austenite grain boundaries so that localized corrosion by the electrochemical mechanism is possible.

Corrosion by Agricultural Chemicals

Evidently there has been a scarcity of data accumulated about the corrosive effects of various agricultural chemicals such as sprays, dusts, spray emulsions and fertilizers on aircraft structural materials and finishes. As a result, the Texas Engineering Experiment Station undertook an extensive test program to determine the optimum in structural materials and coatings to withstand attack by these media. The resulting data might well be of interest to industries other than those concerned with manufacture and maintenance of crop-dusting aircraft and dispersing equipment.

Results of the experiments were summarized in an article by C. F. Schreiber of the Station in last September's *Agricultural Chemicals*. In brief, type 302 stainless steel and glass-reinforced polyester laminates were the only structural materials that

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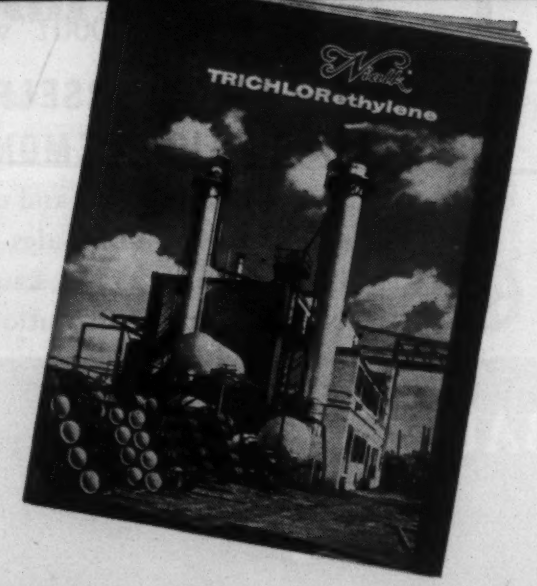

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INSTRUMENTS

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offered complete protection from all of the solutions investigated. Monel metal resisted corrosion reasonably well, but brass, aluminum and chromium-molybdenum steel were all destroyed by certain of the chemicals.

Five alloys were tested: 2024-T3 alclad sheet, 4130 chromium-molybdenum sheet, brass alloy sheet, Monel metal sheet, and type 302 stainless sheet. Four structural plastics were investigated: clear vinyl sheet, clear Plexiglas sheet, and two types of glass reinforced polyester resins. Five finishes were investigated: furan, epoxy-base, vinyl-base, modified chlorinated rubber, and liquid neoprene.

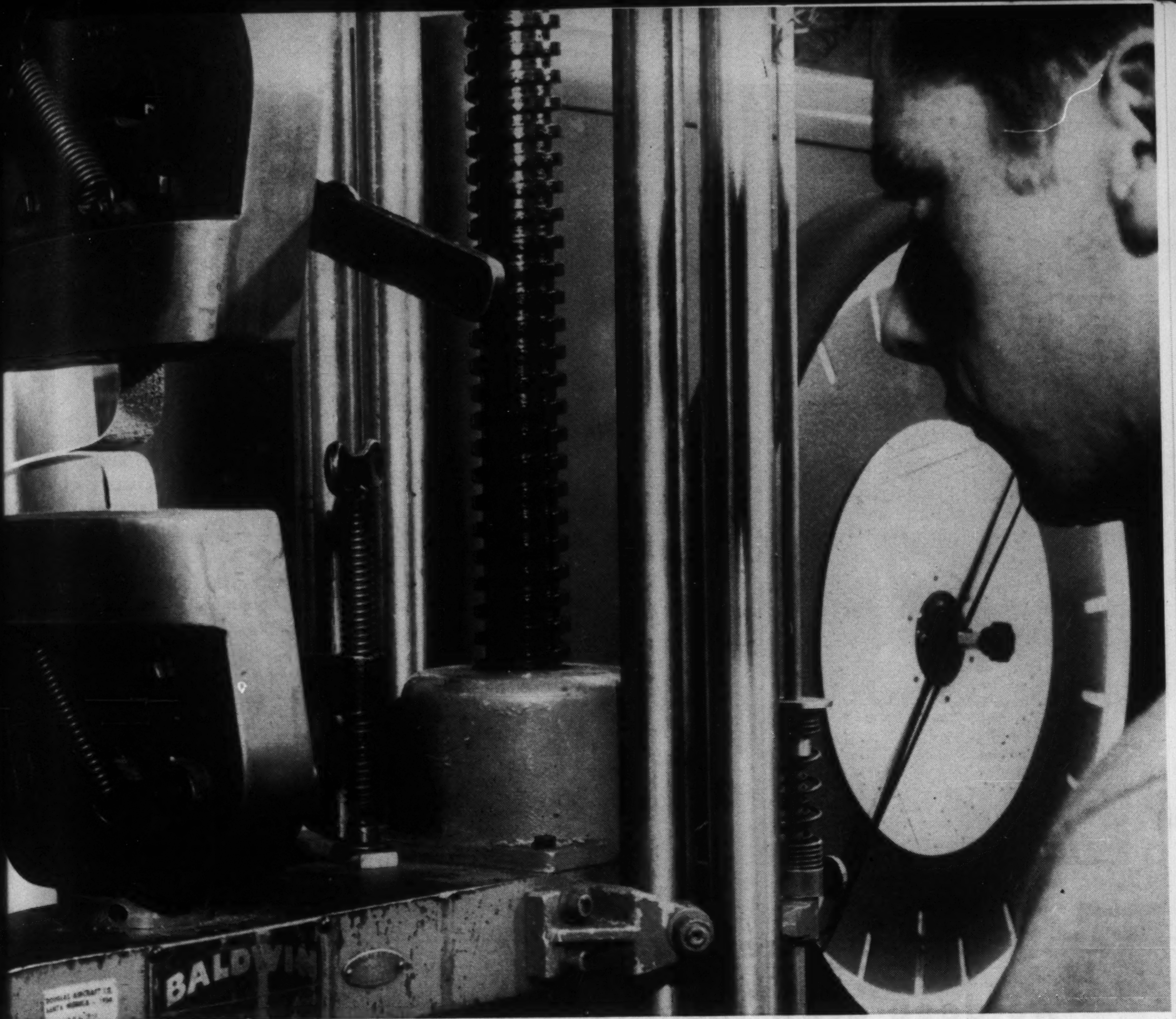
Bare metal

The 2024-T3 alclad sheet was rapidly and severely attacked by sodium cyanamide and TCA herbicides in the partially submerged tests. A variety of aluminum alloys was tested with TCA and all showed severe corrosion. Corrosion by this material can be inhibited or prevented by mixtures of sodium chromate or sodium dichromate. In atmospheric tests, 2024-T3 was totally destroyed by the TCA solution, commercial fertilizer (8-8-8) and magnesium chlorate solution. DDT dust, Toxaphene-sulfur dust, Bordeaux mixture and arsenate dust caused metal pitting.

Data collected on 4130 steel indicates than an applied finish is mandatory for this material. Average time for severe metal action in partially submerged tests was 6 days, and it was attacked very rapidly under all environments in atmospheric tests.

Half-hard brass was severely attacked in partially submerged tests by the cyanates, cyanamides and sulfamate compounds. Rapid interfacial destruction was noted after 30 days. It demonstrated essentially identical destruction properties in atmospheric and submerged tests.

Monel metal was excellent in partially submerged tests, with the exception of highly concentrated



Douglas Aircraft's new tear and peel tests prove versatility of 5000-lb. Baldwin machine

Douglas Aircraft Company finds their versatile Baldwin gives accurate, flexible testing in two new tests devised by them. At their Santa Monica, California Materials Laboratory tear and peel tests on titanium sheet and metal bonding adhesives, respectively, are being run on this 5000-lb. universal machine.

The tear test is used to determine usable quality sheet before release to the factory. It also measures brittleness, formability and strength. The test is conducted on the Baldwin by applying tension loads to a specially-prepared specimen engaged in steel hooks. By pulling the ears of the specimen, tearing originates at a pre-set point produced by a notch. The load increases until reaching the force required to start the tear from the notch. Then the load drops off rapidly or slowly in relation to the brittleness or ductility of the material. The load is autographically recorded along with the strain during the test.

Their peel test operation measures tensile strength of metal bonded specimens. Test panels are gripped in the jaws of the Baldwin machine and are peeled apart at a jaw separation rate of two feet per minute, separating the bond at a rate of one foot per minute. An autographic record versus crosshead motion is obtained. The test includes measurement of average adhesive film thickness and type of failure.

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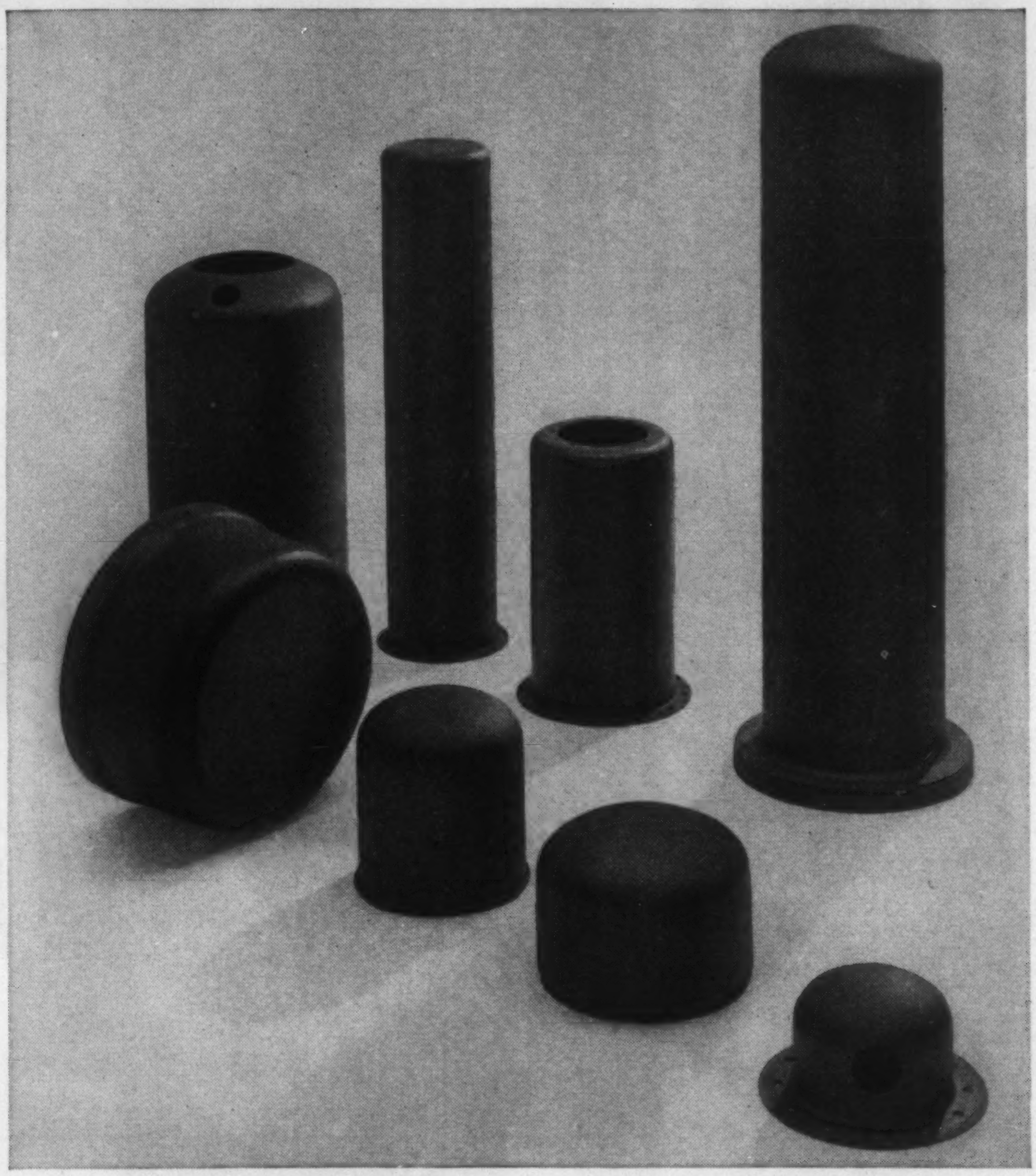

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potassium cyanate solution, which gave a slight pitting effect. Under atmospheric environment Monel exhibited higher corrosion rates, pitting commencing at 50 days when exposed to DDT dust, Toxaphene-sulfur dust, potassium cyanates and arsenate dust insecticides.

Type 302 stainless demonstrated complete resistance to corrosion throughout the entire submerged tests. In atmospheric tests, it exhibited excellent resistance to all chemicals except Toxaphene and sulfur dust insecticides.

Structural plastics

TEPP, Stamite, and Parathion solutions attacked vinyl plastics sheet rapidly. Softening effects were noted rather quickly with Parathion, whereas Aramite and TEPP commenced to discolor and soften at 10 to 17 days, respectively. Plexiglas was destroyed in 6 days by the TCA solution. The cyanates, cyanamides, and Parathion solutions caused discoloration in the Plexiglas, but no softening was evident.

The two reinforced polyester resins were tested for 40 to 50 days and showed excellent resistance to all solutions.

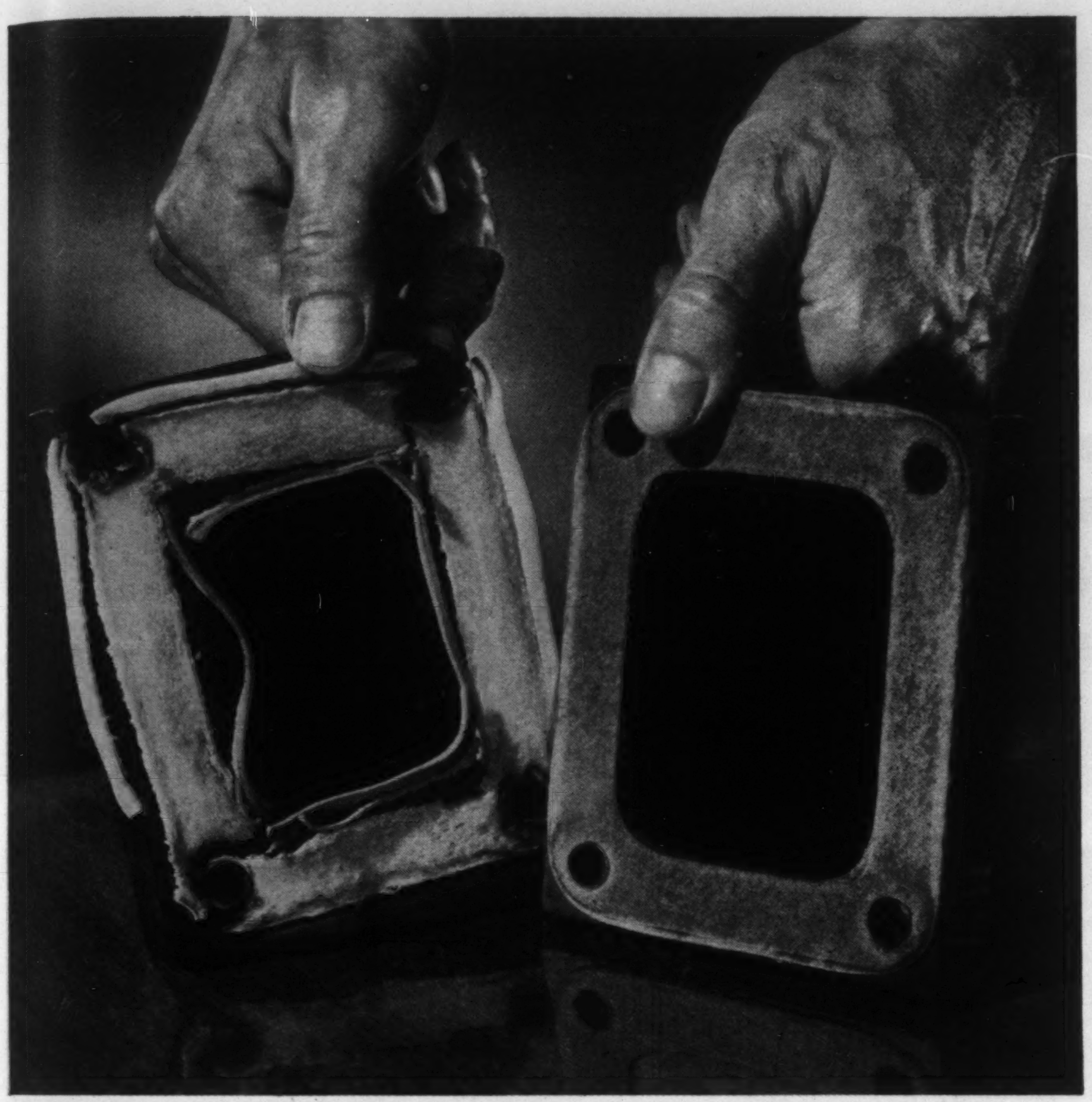
Coatings

None of the applied coatings provide a perfect corrosion-free finish against all agricultural chemicals. Furan finish with the butyral wash primer demonstrated excellent resistance to the vast majority of chemicals tested. Physical properties of this type of finish makes it suitable for aircraft use and it may be sprayed, brushed or dipped, with no particular problems in application.

Books . . .

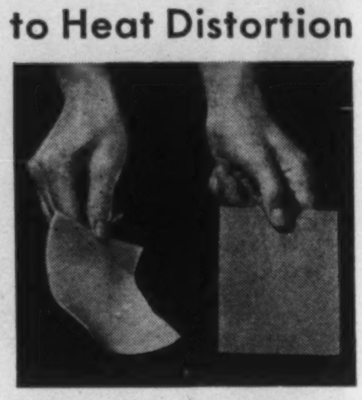
The Inspection and Testing of Metals. *The Institution of Metallurgists. London S.W. 1, England. 1955. Paper 6 by 9 in. 119 pp. Price $2.20.*

This book contains a series of five lectures delivered at the Institution during 1954. Covered are inspection of metals in service, in-



Cold flow resistance of TEFLON* and reinforced TEFLON (DUROID 5600) was tested at 700° F., under a torque of 35 pounds and a flange pressure of 1,000 p.s.i. After 2 hours the flanges were cooled and the bolts retightened. The flanges were then exposed to the heat for another 2 hours. Results are as pictured. The gasket of TEFLON (left) extruded extensively on all edges and lost all bolt torque. DUROID 5600 did not extrude and retained 15 pounds bolt torque, demonstrating significantly improved resistance to cold flow.

Greater Resistance to Heat Distortion



TEFLON (left) distorted badly when subjected to 720° F. and then cooled. Reinforced TEFLON (DUROID 5600) exposed simultaneously to the same temperature retained flatness, demonstrating greater dimensional stability at high temperatures.

SOME IMPORTANT TEST VALUES

Tensile Strength, MD, psi	2500
Tensile Strength, CMD, psi	1500
Compressibility, 5000 psi, %	8
Thermal Expansion Coefficient per °F., 73-140°F.	2.7×10^{-5}
Heat Distortion Temperature, °F.	
66 psi	500+
264 psi	500+
Deformation under Load, %	
1200 psi	2*
2000 psi	3*
Coefficient of friction against polished steel,	
static	.21
kinetic	.14
Specific Gravity	1.90

*Made up of actual flow and also of compression under load. Data to indicate breakdown between these two portions is being obtained.

ROGERS REINFORCES "TEFLON" TO REDUCE ITS COLD FLOW

Rogers DUROID 5600 is a combination of TEFLON and inert fibers, blended into an homogeneous sheet material. This new material is not a replacement or a substitute for TEFLON, but rather an extension of it. TEFLON has better electrical characteristics and dry lubricating qualities. DUROID 5600, however, has much of TEFLON'S resistance to chemicals, and is greatly superior to TEFLON in resistance to cold flow and heat distortion.

*Registered trademark of DuPont Company for its tetrafluoroethylene resin.

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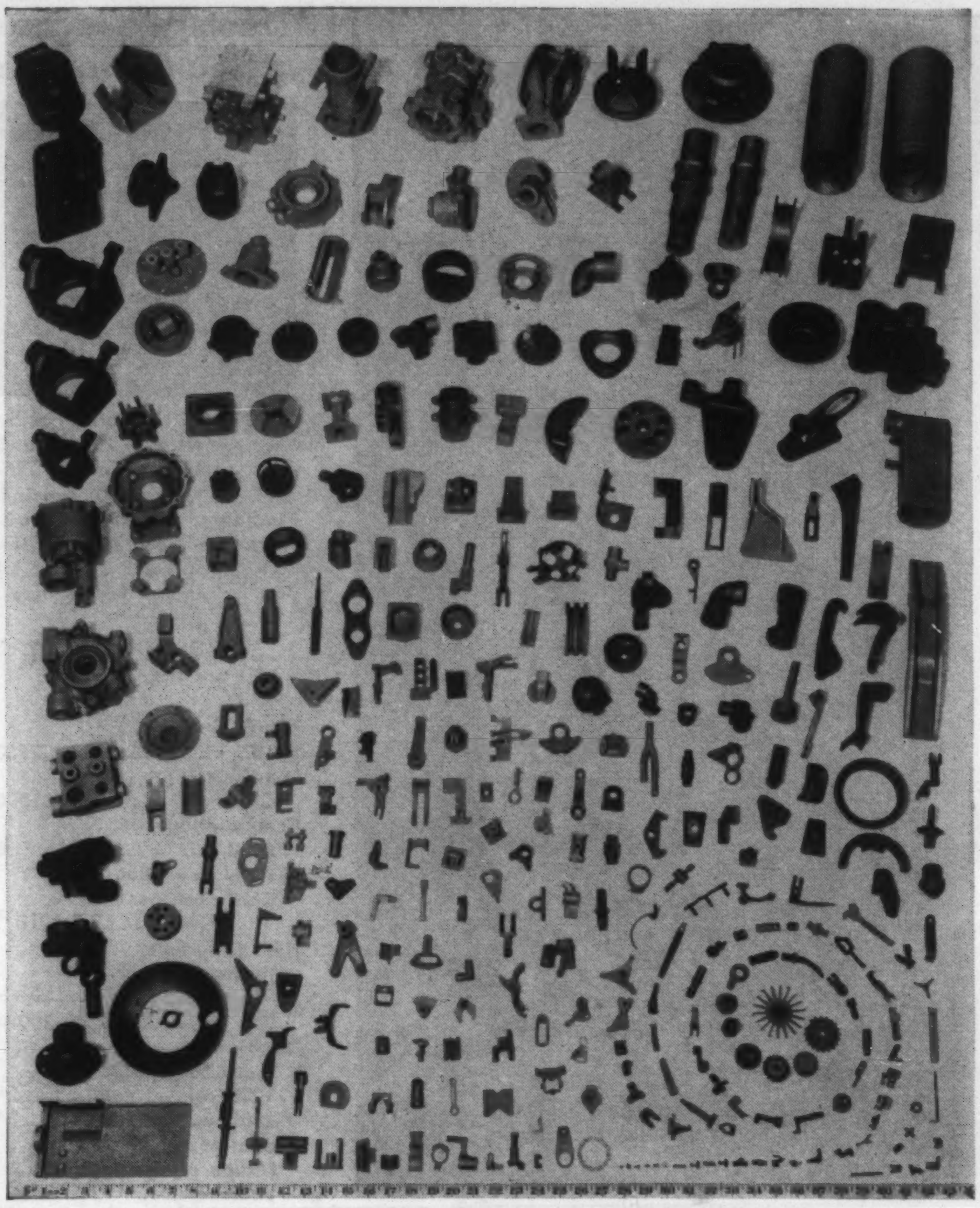

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¼ ounce to 30 pounds . . . up to 12 inches in length . . . 160 ferrous and nonferrous alloys

Precision Metalsmiths makes them all—a million pieces for your production or a few at a time, as you develop a product. Pictured above are some of the investment castings we're making regularly.

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PRECISION METALSMITHS, Inc.

Investment Castings

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Contents Noted

Books . . .

spection in the steel industry, inspection of nonferrous metals, methods of destructive and nondestructive testing and batch testing and sampling of metals. The series is designed as a refresher course in the subjects covered.

Principles of Metal Casting. *Richard W. Heine and Philip C. Rosenthal. McGraw-Hill Book Co., Inc., New York, N.Y. 1955. Cloth 6 by 9 in. 639 pp. Price $7.50.*

This book prepared in cooperation with the Textbook Committee, Educational Division, American Foundrymen's Society is intended for use as a textbook in college courses at the beginning level of instruction in metal casting. For the student of metallurgical engineering, major emphasis is placed on metallurgical aspects of foundry processes and materials. By selecting certain chapters, mechanical engineering students can be given a course in which the principles of foundry processes and the utilization of castings for engineering purposes are emphasized.

General Foundry practice is discussed in 9 chapters, nonferrous practice for aluminum and copper alloys is covered in 4 chapters while ferrous practice occupies 8 chapters. A chapter is devoted to design considerations. Numerous references contribute to the value of the book as an introduction to foundry practice.

Theoretical Metallurgy. *U. Dehlinger. Springer-Verlag, Berlin, Germany. 1955. Cloth 6 by 9 in. 242 pp. Price $6.50 (in German).*

This book discusses the latest developments in metallurgical physics. Chapters are devoted to the crystallographic background, electron effects in the crystal lattice, structure of the elements in the periodic system, heat of formation and lattice structure of alloys, physical properties of the elements and their alloys, phase relationships and transformation kinetics.

(More Book Reviews on p. 204)

How to produce a Laboratory Scale to sell for only $29.50

CASE HISTORIES FROM
MT. VERNON FILES

Manufacture a laboratory balance as accurate, as fine-looking as this Ohaus Cent-O-Gram* — capacity 311 grams, sensitivity to .01 gram — to sell for only $29.50? Realistically, you'd have said it was impossible — but here it it!

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And low cost means low first cost too; that's why Mt. Vernon has been a constant supplier to Ohaus for many years. From die cost to finished casting, Mt. Vernon has both the complete die casting service and the facilities it takes to produce parts like these at minimum cost in any quantity. We have 162,000 square feet of the most modern equipment for making dies and for die casting aluminum and zinc. Mt. Vernon service comprises completely coordinated designing, die-making, casting, and machining, all under one roof.

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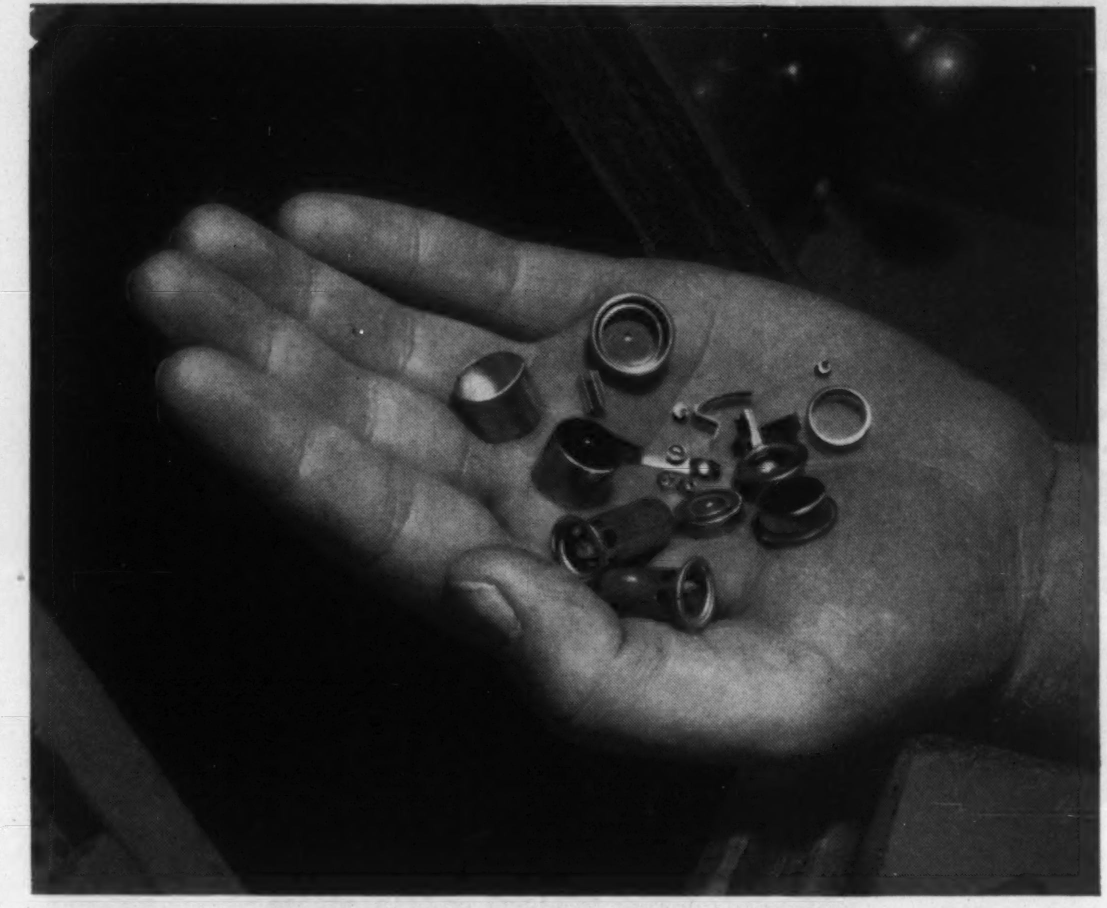

Lorco Compounds and Chips solve intricate finishing and cleaning problems on small electronic components

In Sylvania Electric's new plant in York, Pennsylvania, a million or more precision electronic parts are turned out every day. Some of the tolerances are as close as ±.0005 inch.

Meeting these high production demands alone presented a tough problem to plant engineers. But, there still remained the tremendous hurdle of de-burring, finishing and cleaning these myriads of tiny parts.

Hand finishing was out of the question because of time and cost barriers. Experiments with barrel finishing proved that Lorco Compounds and Fused Aluminum Oxide Chips held the solution. Not only did they maintain the extremely close tolerances, but they provided the required low micro-inch finishes and chemically clean surfaces as well.

Today, an exact schedule has been worked out to control the amount and type of both chips and compounds for each of the variously shaped, minute parts. Finished components, by the million, come out burr-free, chemically clean and ready for installation.

Lorco Chips and Compounds are offering truly amazing answers to the problems of scores of manufacturers . . . for thousands of parts . . . of all shapes and sizes. Write for detailed information about our free sample processing service and your copy of the new manual, "The Lorco Method of Precision Barrel Finishing."

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MANUFACTURERS OF BARREL FINISHING COMPOUNDS
TUMBLING BARRELS — MEDIA AND AUXILIARY EQUIPMENT

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Contents Noted

Books . . .

The Metallurgy of Zirconium. *Edited by Benjamin Lustman and Frank Kerze, Jr. McGraw-Hill Book Co., Inc., New York, N.Y. 1955. Cloth 6 by 9 in. 776 pp. Price $10.00.*

This book is volume 4, Division VII of the National Nuclear Energy Series. Written by more than 50 experts, it presents an account of the occurrence, reduction, refining, properties and uses of zirconium and zirconium alloys. Much information is presented which heretofore has been available only in the form of Atomic Energy Commission classified documents.

The book is divided into 12 chapters covering production methods, melting and forming of zirconium and its alloys, joining, finishing, physical metallurgy and alloy systems, corrosion resistance, analytical chemistry and applications. Metallography and industrial safety are covered in appendices.

Plastics and Building. *E. F. Mactaggart and H. H. Chambers. Philosophical Library, New York, N.Y. 1955. Cloth 8 by 10 in. 181 pp. Price $12.00.*

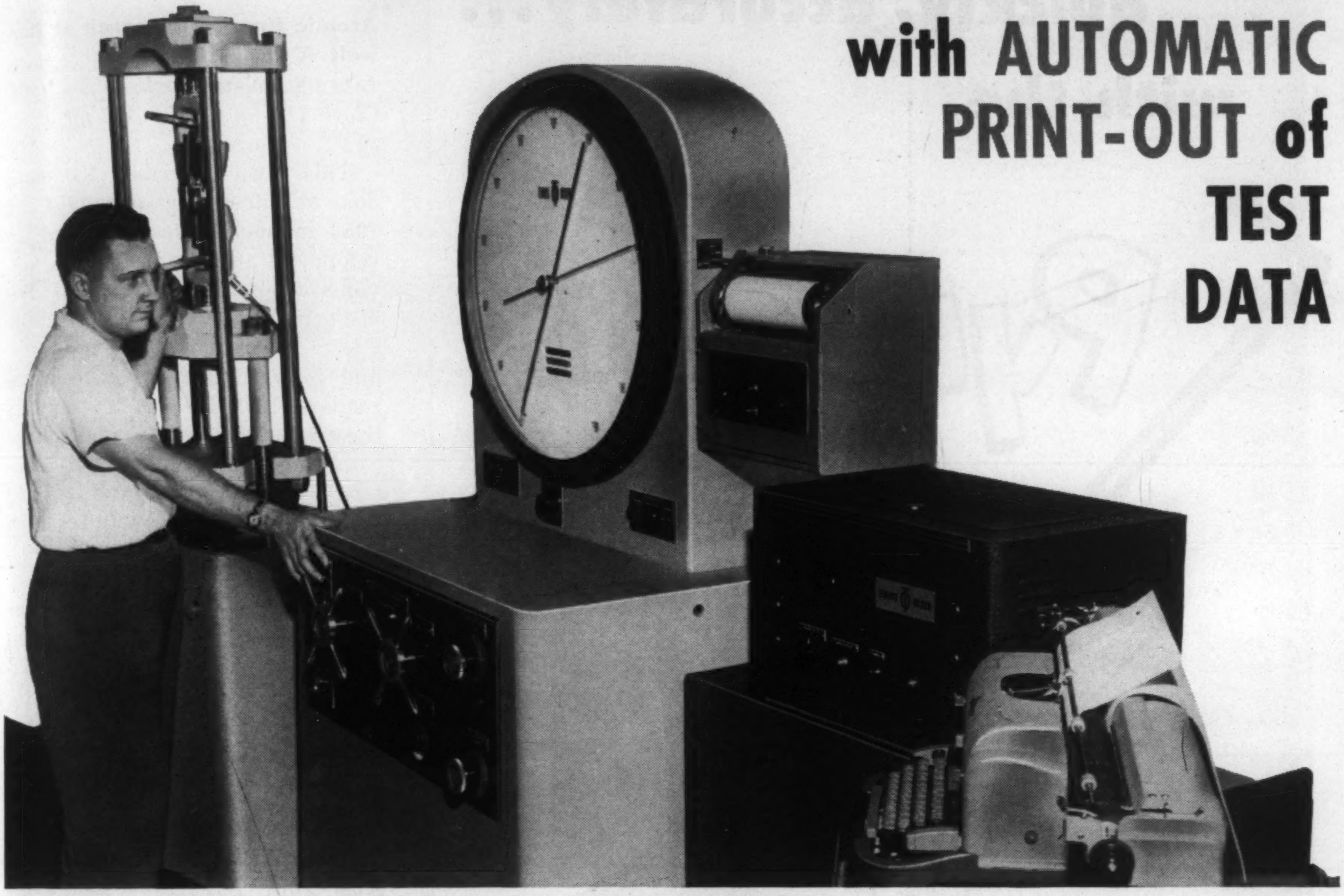
Although the title indicates that this book is intended primarily for the architect and builder, the material is presented in such a fashion that it will be useful also to the industrial designer. This book was written to give an overall picture of the properties, production and uses of plastics materials, including only sufficient information to allow the designer to assess the value and make a logical selection of a plastics for a particular application.

Subjects covered in the 18 chapters include molecular structure and the chemistry of molecules, forms in which plastics are used, molding and other methods of forming, adhesives, laminates, materials and production statistics, applications and designing in plastics. A glossary of technical terms and a list of British Trade Names is included.

(More Book Reviews on p. 206)

Another **OLSEN** *First!*

an AUTOMATIC TESTING MACHINE with AUTOMATIC PRINT-OUT of TEST DATA



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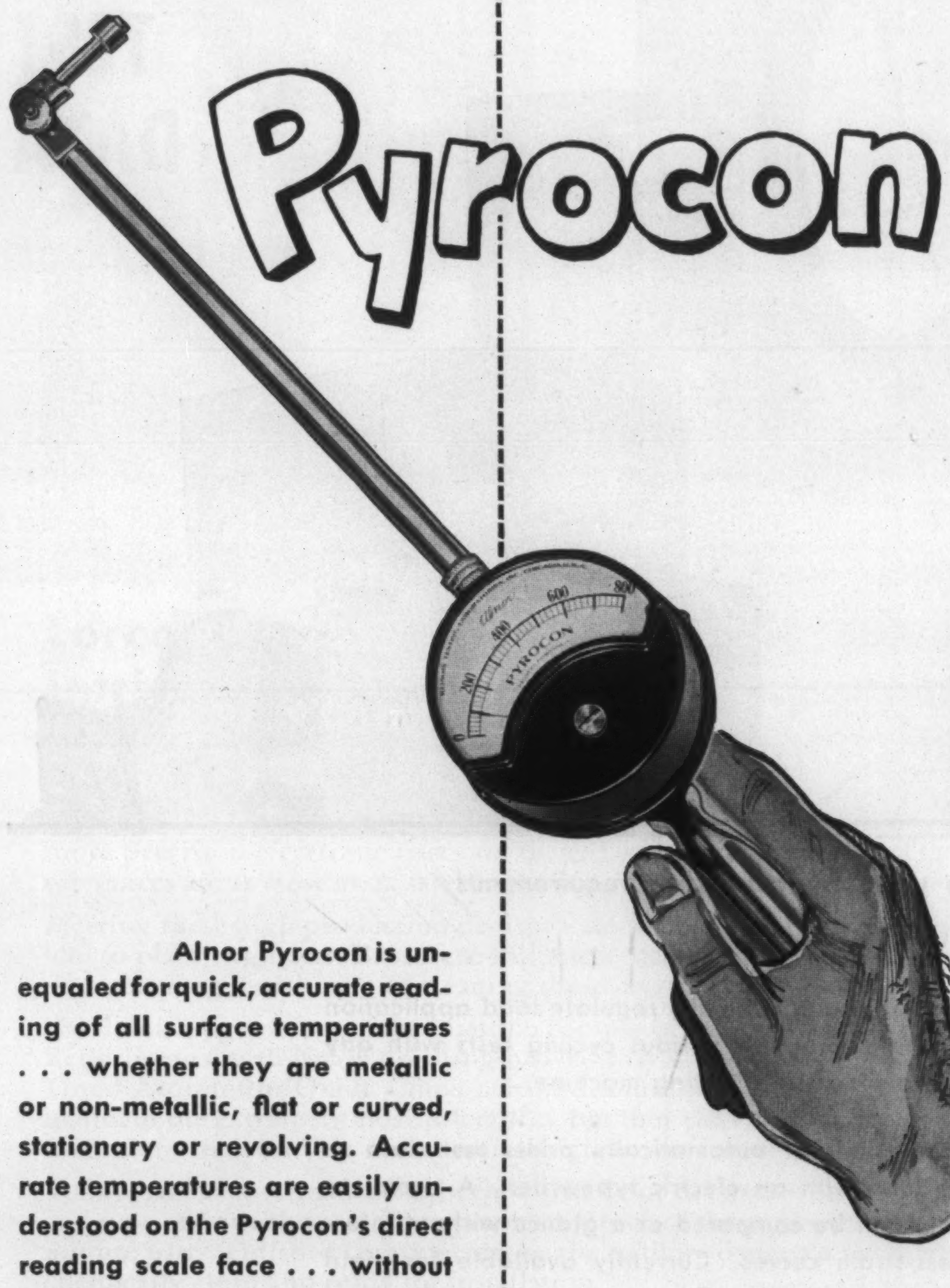
Take surface temperatures quickly, accurately... with the



Alnor Pyrocon is unequaled for quick, accurate reading of all surface temperatures . . . whether they are metallic or non-metallic, flat or curved, stationary or revolving. Accurate temperatures are easily understood on the Pyrocon's direct reading scale face . . . without interpolation or need of conversion tables. A wide selection of thermocouples and extension arms permits adaptation to many types of service. For complete details and prices, send for Bulletin No. 4257. Illinois Testing Laboratories Inc., Room 522, 420 N. LaSalle Street, Chicago 10, Ill.

Alnor

PRECISION INSTRUMENTS FOR EVERY INDUSTRY

For more information, turn to Reader Service Card, Circle No. 398

Contents Noted

Books . . .

Atomic Energy Research at Harwell. *K. E. B. Jay. Philosophical Library, New York, N.Y. 1955. Cloth 5½ by 8½ in. 143 pp. Price $4.75.*

This book describes the work done at Harwell between 1951 and 1954 in nuclear research and development and supplements a previous book issued in 1952. The book is divided into two parts. Part 1 covers the major programs and is written for non-technical readers. Included are chapters on the production, reactor and isotope programs, development of electronic instruments and special techniques. Part 2 covers research in physics, chemistry and metallurgy and is written for the scientist who is not a specialist in the field. Changes in security regulations have made it possible to include details on some subjects which were mentioned only in general terms in the previous book.

Designing for Industry. *F. C. Ashford. Philosophical Library, New York, N.Y. 1955. Cloth 5½ by 8½ in. 222 pp. Price $7.50.*

This book aims at providing a reliable picture of the profession of product designing as it exists in Great Britain. It is divided into 12 chapters covering such subjects as, the designer's role, aesthetics, visualization, rendering, model making, methods and materials, and marketing considerations.

It has been written for practicing designers, students and others whose work brings them into direct contact with the design of a product.

Handbook of Industrial Statistics. *Albert H. Bowker and Gerald J. Lieberman. Prentice-Hall, Inc., New York, N.Y. 1955. Cloth 6 by 9 in. 184 pp. Price $5.00.*

This book is a reprint of the section on industrial statistics in the *Handbook of Industrial Engineering and Management* by W. G. Ireson and E. L. Grant. After discussing descriptive statistics briefly, the book deals with production problems. Thorough guidance

SIDE WALLS AND FLAT ARCH ROOF on this batch-type annealing oven at Terre Haute Malleable & Mfg. Corporation, Terre Haute, Indiana, were installed quickly and economically with a castable refractory—Kast-O-Lite—a Lumnite-base castable manufactured by A. P. Green Fire Brick Company, Mexico, Mo.

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Lumnite-base castables are bringing new speed and economy to countless refractory installation and repair jobs. They're so easy to use. Just add water, mix, and you're ready to place refractory or insulating concrete.

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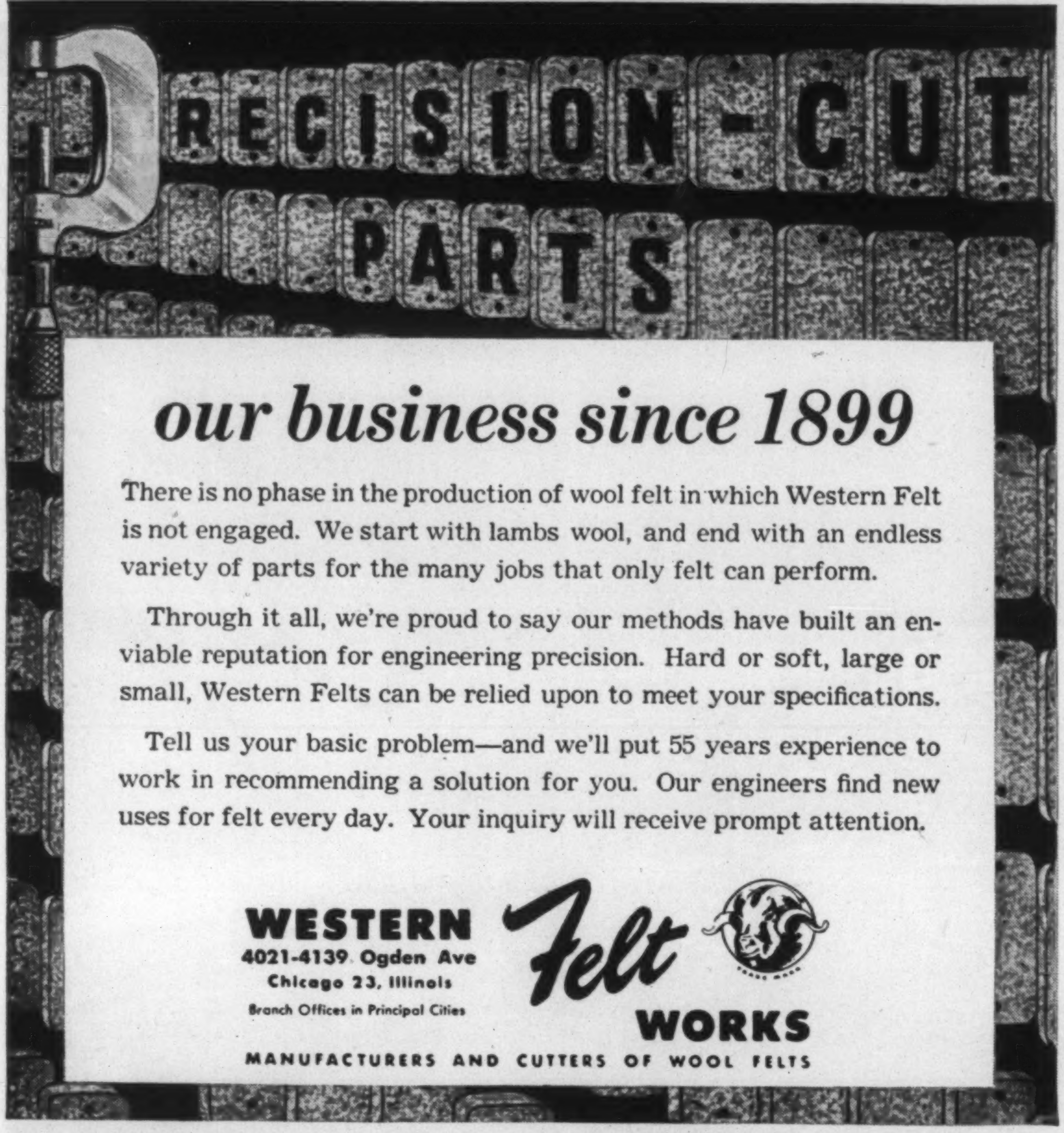

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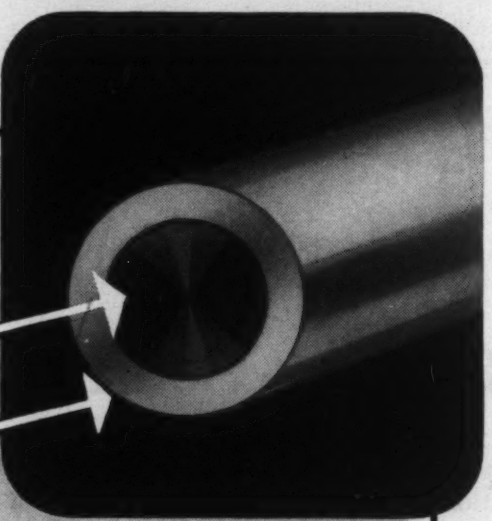

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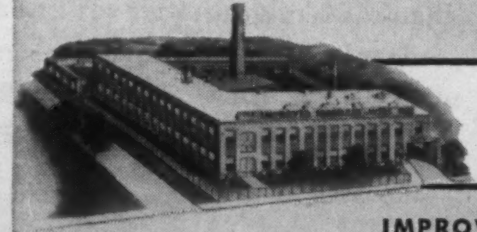
A wide range of precious metal-base metal combinations in sheet, wire, or tubing are quickly available from "IMPROVED." Custom-made to your specifications.



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Contents Noted

Books . . .

is presented on sampling inspection, common significance tests, curve fitting and analysis of variance. It is intended to serve as a tool for engineers, statisticians and teachers in industrial statistics.

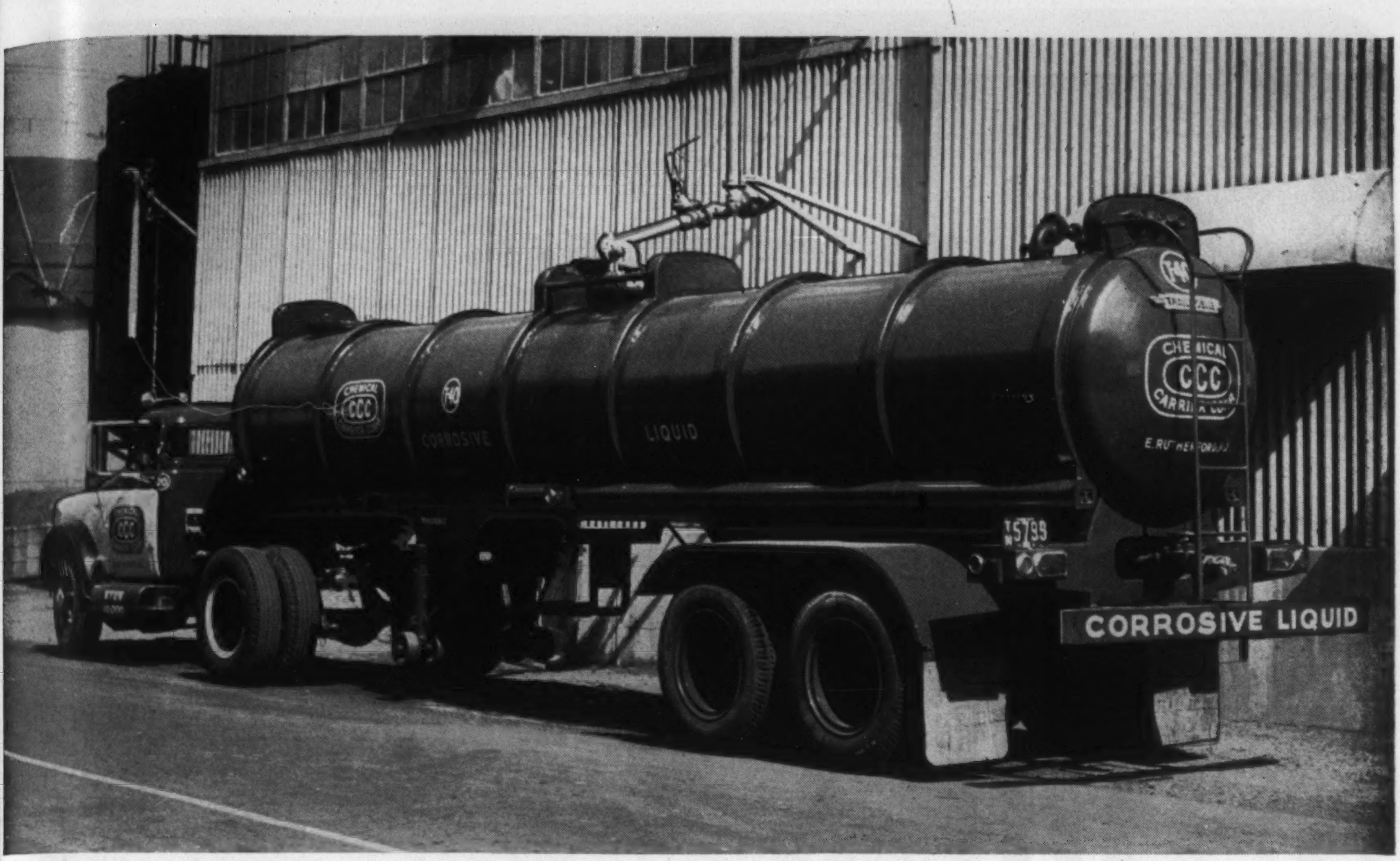
Bearing Lubrication Analysis. *R. R. Slaymaker. John Wiley & Sons, Inc., New York, N.Y. 1955. Cloth 6 by 9 in. 108 pp. Price $5.00.*

Written for the machine designer rather than the lubrication engineer this book covers the general principles of lubrication analysis in bearing design. The treatment stresses sleeve bearings which is the most common type bearing found in machines. The discussion is fully illustrated with case histories and numerical examples. Included are a chapter on the characteristics of various bearing materials, an analysis of the so-called oilless bearings and an outline of hydro-dynamic theory as a guide to the design of bearings to be lubricated from an external source. A practical method of predicting temperature rise and oil viscosity in one operation eliminates trial and error solutions of the problem.

Reports . . .

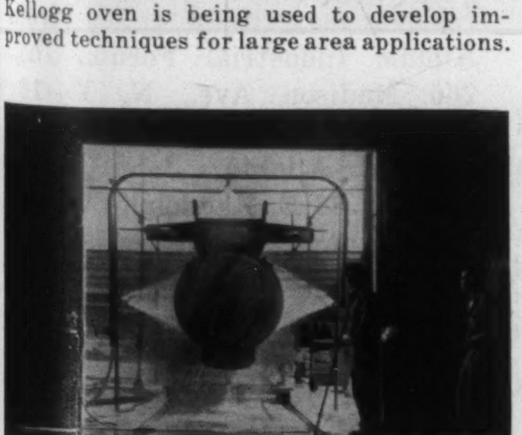
Radiation vulcanizing VULCANIZATION OF RUBBER WITH HIGH-INTENSITY GAMMA RADIATION. *Wallace W. Jackson and Denver Hale. U. S. Air Force. Air Research and Development Command, Wright Air Development Center, Materials Laboratory, Wright-Patterson Air Force Base, Dayton, Ohio. Apr. 1955. 37 pp. photos, drawings, graphs, tables. Available from Office of Technical Services, U. S. Dept. of Commerce, Washington, D. C. $1.00.* PB 111675

Techniques of vulcanizing both natural and synthetic rubber polymers, using high intensity gamma radiation are described. Evaluation of this technique shows considerable promise in developing elastomers for specialized



KEL-F® dispersion-coated tank truck transports corrosive chemicals

BAKE OVEN at Kellogg Plant, Jersey City, N.J. Overall length 85 ft., width 12 ft., height 12 ft., iso-thermal control, ±5°F. This new Kellogg oven is being used to develop improved techniques for large area applications.



QUENCHING—After final baking, tank is quenched to produce tough, transparent, flexible coating.

This tank, which is designed to transport corrosive chemicals without danger of contamination of the final product, was spray coated with KEL-F Dispersions at the Kellogg plant in Jersey City, and baked-fused in a specially built oven large enough to complete each coating in a single operation. Preliminary tests were carried out with a slightly smaller tank, and the correct techniques developed before proceeding with the coating operations on the tank truck.

KEL-F DISPERSIONS—NEW WEAPON IN FIGHT AGAINST CORROSION

KEL-F Dispersions are finely divided fluorocarbon plastic solids in a volatile medium. Applied by spray, dip or spread coating, they are fused by heat into a tough, impervious coating—firmly bonded to the surface on which applied, and providing a chemical and temperature resistant surface that is anti-sticking and self-cleaning.

This liquid chemical carrier is evidence that the range of applications for KEL-F Dispersions is not limited by size, and that present techniques of dispersion coating can be applied to tanks and other outsize equipment. There are experienced applicators of KEL-F Dispersions, serving nearly every major industrial area. They can show you how this fluorocarbon polymer can come to your aid in your fight against corrosion and high processing temperatures. For more information, send for KEL-F Dispersion Manual, and list of applicators.

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STOOLS

- weighing 10,000 pounds each
- alloyed 25% Cr — 12% Ni
- for 1750°F. temperatures

DURALOY

These stools should offer a very pertinent tie-in with your casting requirements. Essentially, they are alloyed to resist heat. They're typical of the heavy high alloy castings we are equipped to turn out.

They will serve also to indicate what we can do in the way of producing castings to resist not only high temperatures but severe corrosion or combinations of heat and corrosion, as well.

Today, we can offer several distinctly different types of castings in the high alloy field including static, centrifugal and shell-molded.

Many in both the metal working and processing fields have come to look upon Duraloy as the leading producer of exclusively high alloy castings. This reputation has been built on many years production of sound castings properly alloyed. We'll be glad to discuss your high alloy casting requirements.

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For more information, turn to Reader Service Card, Circle No. 429

Contents Noted

Reports . . .

uses, such as producing high temperature oil resistant rubber compounds and for improving the compression set of specialized rubber compounds.

Fatigue of aluminum AXIAL-LOAD FATIGUE PROPERTIES OF 24S-T AND 75S-T ALUMINUM ALLOY AS DETERMINED IN SEVERAL LABORATORIES. *H. J. Grover and W. S. Hyler, Battelle Memorial Institute, Paul Kuhn and Charles B. Landers, Langley Aeronautical Laboratory and F. M. Howell, Aluminum Company of America. 1954. ii, 25 pp. diagrs, photos, 7 tabs. Available from National Advisory Committee for Aeronautics, 1512 "H" St., N. W., Washington 25, D. C.*
NACA Rept. 1190

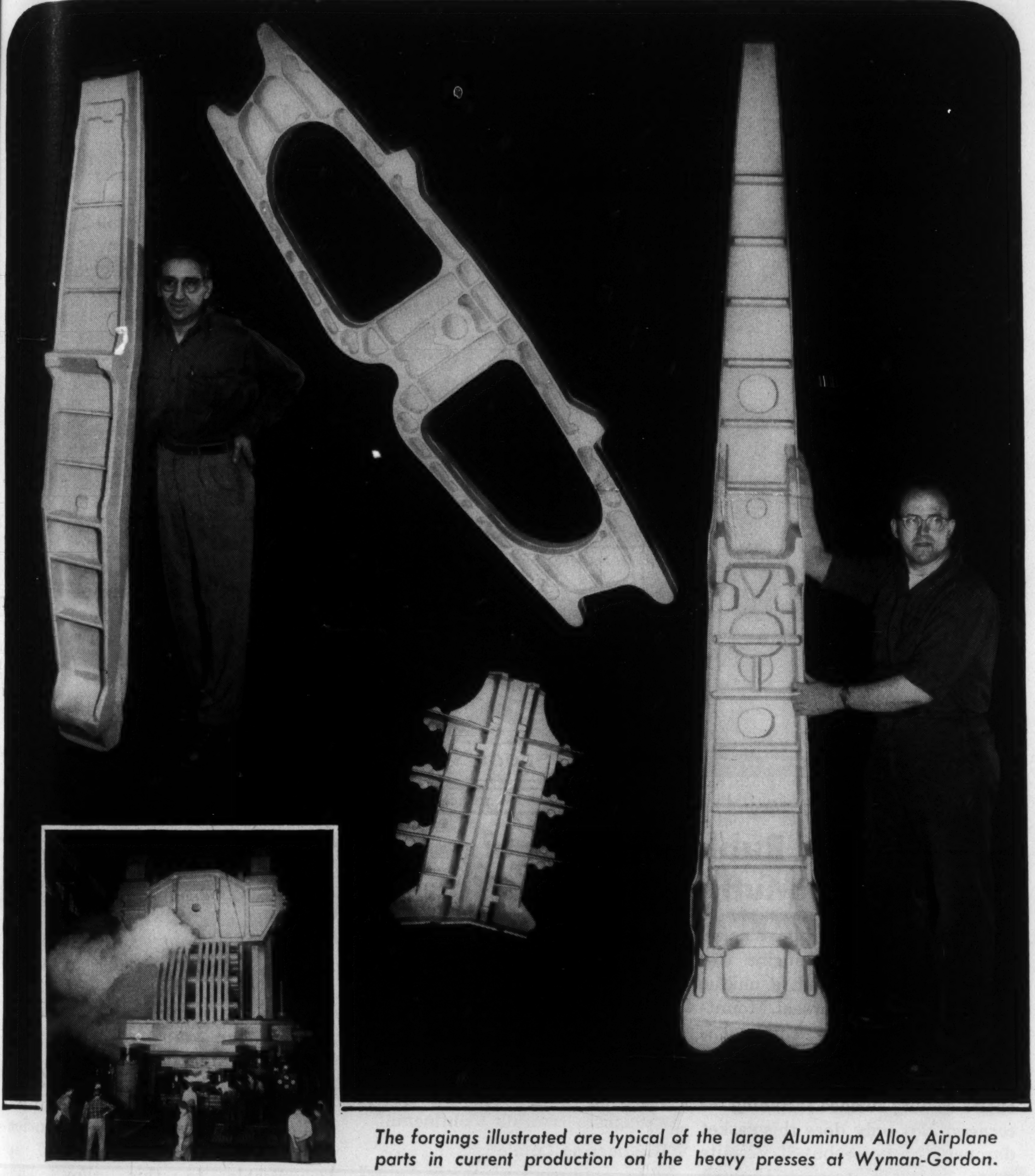
In the initial phase of an NACA program on fatigue research, axial-load tests on 24S-T3 and 75S-T6 aluminum-alloy sheet have been made at the Battelle Memorial Institute and at the Langley Aeronautical Laboratory of the NACA. The test specimens were polished and unnotched. The manufacturer of the material, the Aluminum Company of America, has made axial-load tests on 24S-T4 and 75S-T6 rod material. The test techniques used at the three laboratories are described in detail; the test results are compared with each other and with results obtained on unpolished sheet by the National Bureau of Standards.

Declassified AEC reports

Photocopies of the following reports may be obtained from Atomic Industrial Forum, Inc., 260 Madison Ave., N. Y. 16; Georgia Institute of Technology Library, Atlanta; John Crerar Library, 86 E. Randolph St., Chicago 1; and Stanford Research Institute, Stanford, Calif.

ULTRASONIC WELDING OF ALUMINUM. *J. Byron Jones, Carmine F. DePrisco, and John G. Thomas. Aeroprojects, Inc., West Chester, Pa. Feb. 1955. 48 pp. For du Pont de Nemours (E. I.) and Co. Savannah River Lab.* *DP-107*

At various stages in the development of the ultrasonic welding



The forgings illustrated are typical of the large Aluminum Alloy Airplane parts in current production on the heavy presses at Wyman-Gordon.

A new era in the art of forging has been demonstrated as production goes forward on this 35,000-ton closed die forging press. Larger forgings with thinner sections and closer tolerances than heretofore possible open new concepts in forging design. Wyman-Gordon continues to pioneer by — Keeping Ahead of Progress.

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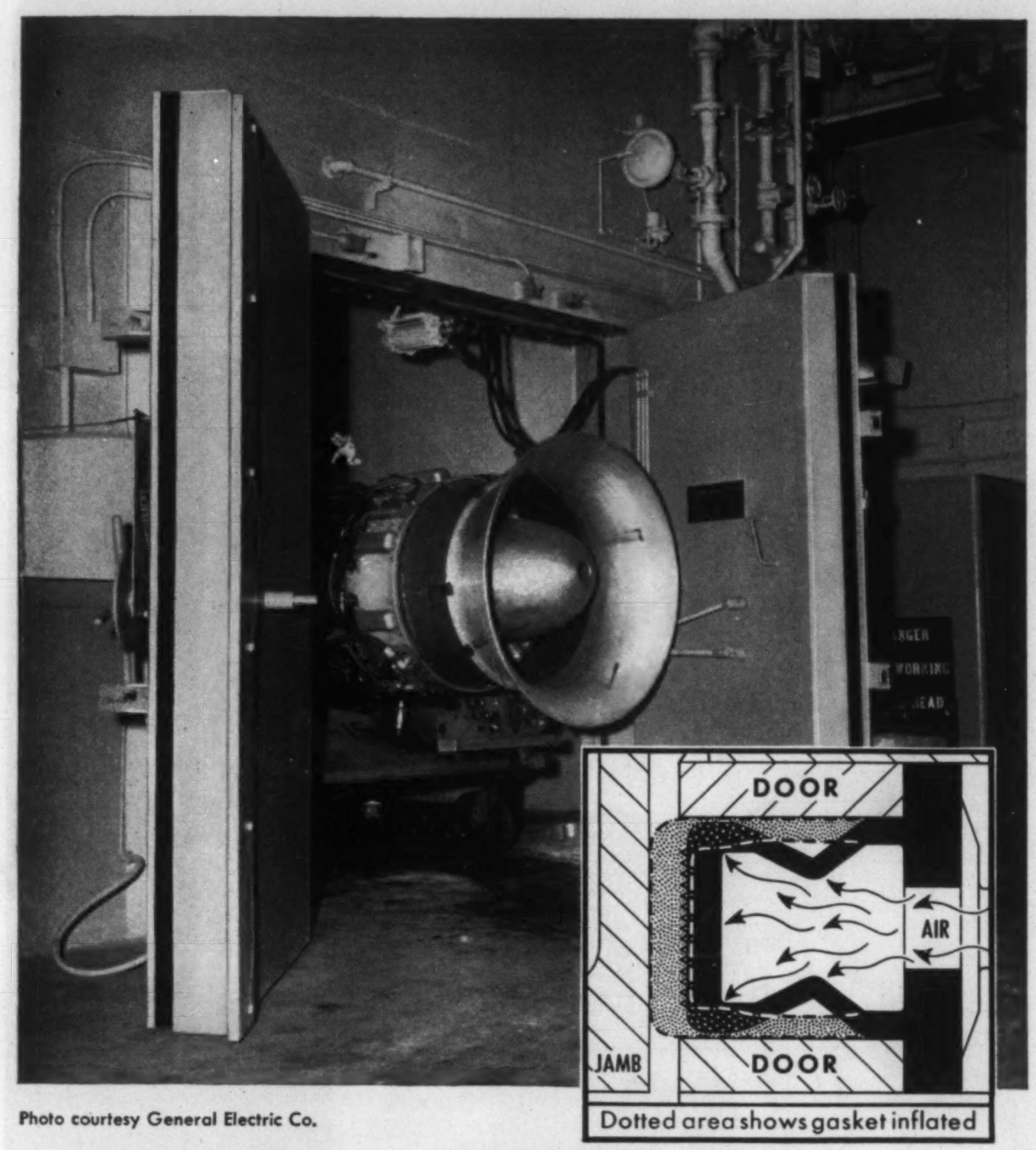

Dotted area shows gasket inflated

Photo courtesy General Electric Co.

Pneumatic Rubber *Door Seal* Muffles Test Cell Noises

To more effectively suppress noise, General Electric jet engine test cells are equipped with a unique pneumatic rubber door seal. Mounted on door perimeter, this seal is designed to expand proportionally and insure a perfect seal over its entire sealing surface *including the corners*. Not only does this gasket dampen the noise but it permits more accurate testing through quieter working conditions.

Continental engineers developed this pneumatic gasket for this and similar applications. Compounded of special flex-resistant rubber, this versatile gasket can be operated with intermittent flexing cycle *or* as a continuous seal—can be adapted to various other types of doors—for *either* pressure or vacuum rooms.

The design of this gasket typifies the engineering skill offered by Continental. When you need "engineered rubber parts"—molded or extruded—enlist the service of specialists—consult Continental.

Engineering Catalog.

In addition to custom-made parts, Continental offers an extensive line of standard grommets, bushings, bumpers, rings and extruded shapes. Hundreds of these are shown in the No. 100 Engineering Catalog. Send for a copy or refer to it in Sweet's Catalog for Product Designers.

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engineered by **CONTINENTAL**

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Contents Noted

Reports . . .

process, test coupons of 1100 aluminum were prepared to evaluate weld strength, the effect of thermal cycling up to 350 C, and corrosion resistance in an environment of 95 C aerated, distilled water. Substantial improvement in weld strength was obtained during the term of the program, and metallographic examination revealed good solid-phase bonding in isolated areas of the ultrasonically affected zone. Thermal cycling up to about 250 C had no effect on weld strength, although higher temperatures produced an adverse effect; improvement in thermal shock resistance may be possible. No effect of the corrosion environment was observed in five months of exposure. The significance of surface cleaning on weld quality was not clearly established.

DEVELOPMENT OF ZIRCONIUM-BASE ALLOYS. Twenty-Second Quarterly Report. (Progress Report No. 23). *J. H. Keeler. General Electric Co. Research Lab., Schenectady, N. Y. Apr. 5, 1955. 17 pp.* (RL-1303) SO-2520

The stress-rupture characteristics of β-annealed Zr are essentially equivalent to those of α-annealed Zr at room temperature and 300 C. However, at 500 C, the minimum creep rate is less and the rupture life is greater than for α-annealed Zr. The 1400 C annealing texture of a metastable body-centered-cubic Zr alloy sheet containing 18% Nb was (111)<112>. The Burgers orientation relation was found applicable to this alloy when transformed to the hexagonal-close-packed phase. The tensile properties of Zr-Ta and Zr-Nb binary alloys are summarized. (For preceding period see So-2519.)

ZIRCONIUM ALLOYS FOR NUCLEAR PROPERTIES. Spectrographic Determination of Aluminum in Zirconium. *L. B. Bronk and R. S. McDonald. General Electric Co. Research Lab., Schenectady, N. Y. July 1955. 8 pp.* (55-RL-1353) SO-2522

An emission spectrographic

Here's a way to get

real toughness

in molded plastic components

MICARTA Glass-Reinforced Polyester Moldings have what it takes for high-strength electrical applications. This exceptionally versatile material has excellent arc resistance, high impact and flexural strength, low power factor and moisture absorption qualities. And it can be accurately molded in the many intricate shapes needed for structural insulating members in electrical equipment.

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polyester moldings

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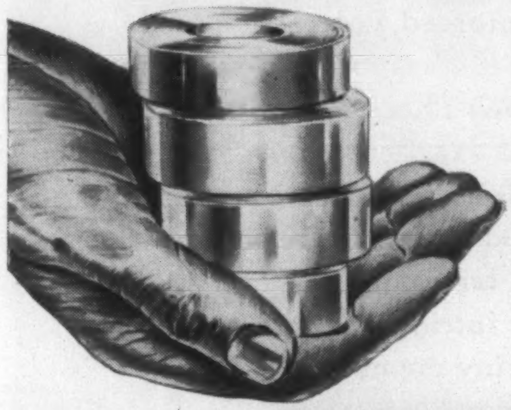

WEIGH FIRST COSTS of CMP restricted specification cold rolled strip steel AGAINST CMP ADVANTAGES

True costs of cold rolled strip steel are oftentimes clouded by unfamiliarity of the full potential with a specially tailored product such as CMP processes.

Typical of the reductions in overall manufacturing costs that can often be recorded with the use of CMP restricted specification strip, is the elimination of manual costs involved in the tear-down and re-assembly of components rejected for malfunctioning due to steel dimensional variations. Where precision fitting of components is essential to satisfactory equipment operation, the extra steel cost for close gauge accuracy is more than offset by greater parts production per machine hour and reduction or elimination of rejects at final assembly. Add to this the lower end product cost resulting from longer tool life, fewer coil changes on production equipment and other labor cost items.

The conclusion often is that it pays to buy a premium specification product to lower the cost of an end product employing cold rolled carbon, alloy or stainless strip steel.

PRECISION COLD ROLLED CMP STRIP STEEL

CMP WHERE YOU CAN GET SPECIFIC SPECS. FOR SPECIFIC JOBS

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HIGH CARBON
Annealed or Tempered
STAINLESS
ALLOY
ELECTRO ZINC COATED

the Cold Metal Products co.
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PLANTS: YOUNGSTOWN, OHIO AND INDIANAPOLIS, IND.
SALES OFFICES: New York • Cleveland • Detroit • Indianapolis • Chicago • Los Angeles • San Francisco

For more information, turn to Reader Service Card, Circle No. 473

Contents Noted

Reports . . .

method using the solution spark, rotating disk electrode technique has been developed to determine aluminum present in Zr-Al alloys in the range of 0.1 to 2% aluminum.

ATTACK ON METALS BY BISMUTH-LEAD-TIN ALLOY AT ELEVATED TEMPERATURES. *Argonne National Lab., Lemont, Ill. Final Report on Metallurgy Program 8.2.3. W. D. Wilkinson. Jan. 15, 1954. 73 pp.* ANL-5262

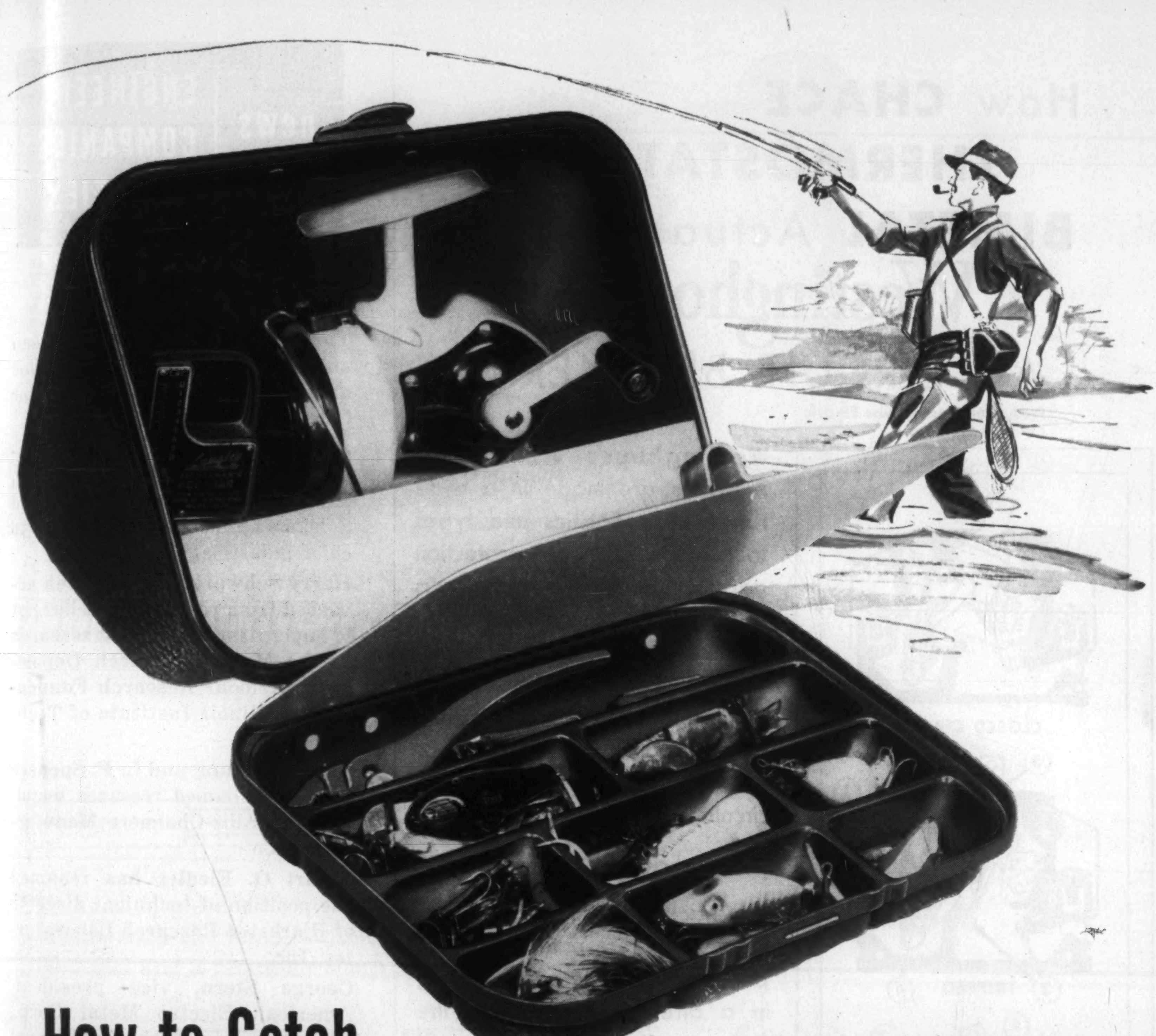
Attack on Al, Be, Ti, Zr, irons, steels, Mo, and W by bismuth-lead-tin alloys was studied. General procedures are discussed and results are analyzed. It was found that Mo was not attacked at 800 C and Be was not attacked at 500 C, but others were visibly attacked. The effects of oxygen on attack is also discussed.

LIQUID METALS HANDBOOK. Sodium-Na K Supplement. *Carey B. Jackson, ed. Atomic Energy Commission, Washington, D.C. and Bureau of Ships. July 1, 1955. 452 pp.* TID-5277

This supplement to the Liquid Metals Handbook includes information specifically on Na and Na K alloys.

Creep THEORY OF DYNAMIC CREEP (K TEORII DINAMICHESKOI POLZUCHESTI). *A. A. Predvoditelev and B. A. Smirnov. Sept. 1955. 12 pp, diagrams. Trans. from Moscow Universitet, Vestnik, vol. 8, no. 8, 1953, p. 79-86. Available from Library of Congress, Photoduplication Service, Publications Board Project, Washington 25, D. C.* NACA TM 1330

An analysis is given of the causes of the increase in creep under varying loads. It is suggested that the increase in creep is due to local rise in temperature over the slip planes, thus facilitating slip. A theory of dynamic creep is proposed, based on the Becker theory of the after-effect, which treats the metal as a granular structure and includes a rate factor. Comparison of the theory with experimental results is reserved for a future paper.



How to Catch a Fisherman

It's said that fishermen buy more things than fish do. Be that as it may, the spinning tackle box by UMCO Corporation of Minneapolis, made of tough, versatile U. S. Royalite, illustrates some of the many advantages of this fine fabricating material. For Royalite is:

1 **Impact Resistant.** Tackle boxes are often banged against rocks or dropped into boats. Royalite can "take it".

2 **Rustproof.** Salt water or fresh, Royalite is completely unaffected. These spinning tackle boxes are often used by skin divers to carry equipment.

3 **Easily Fabricated.** Note molded-in lure compartments and sharp detail. Low-cost wood, resin or metal tools do the job, depending on volume.

4 **Compatible with Metal.** Note the aluminum plate, hinged to the Royalite. The latch fastens to the Royalite. The hinges, handles and buckles are riveted permanently in place.

Royalite is also: . . . *impervious* to most chemicals . . . *lighter in weight* than any commonly used metal . . . *beautiful*, in a wide range of colors and finishes . . . compounded of *plastic* fortified with *rubber* for superior impact resistance.

Want to catch more customers? Design it of Royalite for greater beauty-appeal, better service, much stronger saleability. Write, wire or phone for details to United States Rubber Company, 2638 N. Pulaski Road, Chicago 39, Illinois.

U.S. ROYALITE®

TOUGH, VERSATILE FABRICATING MATERIAL

US RUBBER United States Rubber

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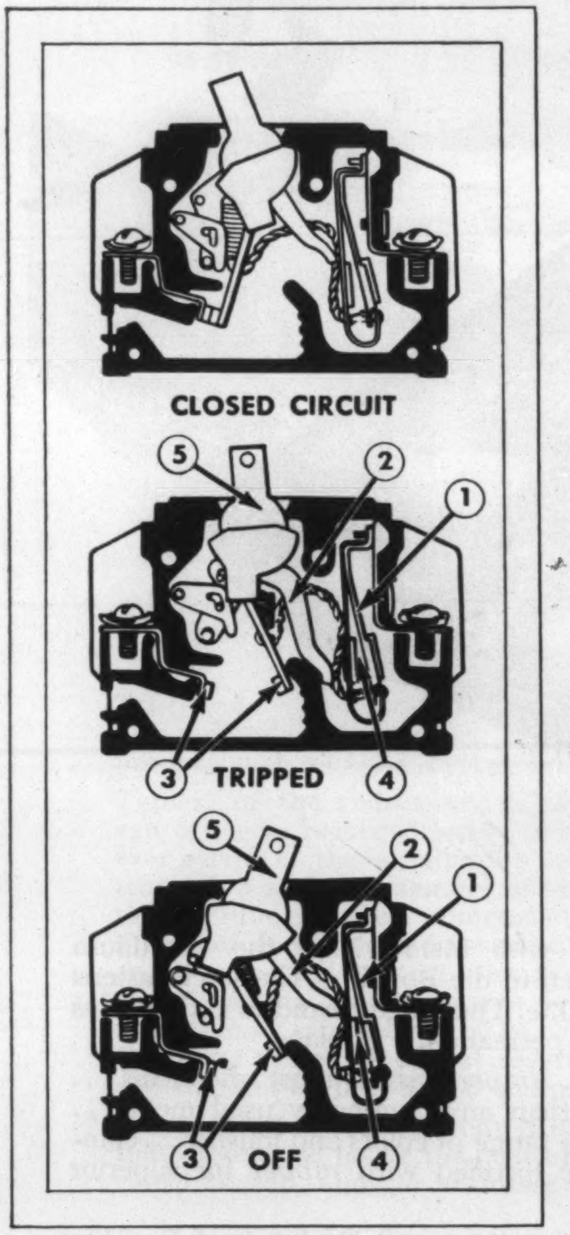

How **CHACE THERMOSTATIC BIMETAL** Actuates the **Westinghouse** AB CIRCUIT BREAKER

Product of Westinghouse Electric Corp., Beaver, Pa.

Westinghouse AB Circuit Breakers are made in a wide range of capacities and types to provide foolproof protection against electrical current faults in residential, commercial or industrial wiring systems. Westinghouse AB Circuit Breakers employ a thermal-magnetic action for *sure* response to gradual or sudden overloads and short circuit faults.

HOW IT WORKS

A Chace Thermostatic Bimetal element (1) responds to temporary overloads by deflecting in a direction away from the spring loaded latching arm (2) causing the contact rocker to break the circuit at contacts (3) in response to the same spring tension. Under conditions of sudden, high overload, the magnetic trip element (4) trips the latching arm in the same manner. A simple flip of the reset handle (5) again closes the circuit after the fault has been cleared from the line.

Chace Thermostatic Bimetal is available in 29 different types, in coil, strip, or in complete elements fabricated to your specifications. To aid the product designer of thermally responsive devices, we offer a free 36-page booklet, "Successful Applications of Chace Thermostatic Bimetal." ***Write today for your copy.***

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Thermostatic Bimetal
1615 BEARD AVE., DETROIT 9, MICH.

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news of ENGINEERS COMPANIES SOCIETIES

NEWS OF ENGINEERS

Theodore A. Haller has been made vice president and director of engineering, American Tractor Corp.

Arthur W. Krause has been appointed chief methods engineer, A-P Controls Corp., to replace Ed Solski who has been promoted to chief industrial engineer.

Harry Schwartzbart has been advanced from research metallurgist to supervisor of welding research in the Metals Research Department, Armour Research Foundation of Illinois Institute of Technology.

Shaochi Huang and **L. F. Spencer** have been named research metallurgists, Allis-Chalmers Manufacturing Co.

Stuart O. Fiedler has resumed the position of technical director of Bjorksten Research Laboratories, Inc.

George Stern, vice president, American Electro Metal Corp., has been given the additional position of vice president and technical director, American Sinteel Corp., new American-Electro subsidiary.

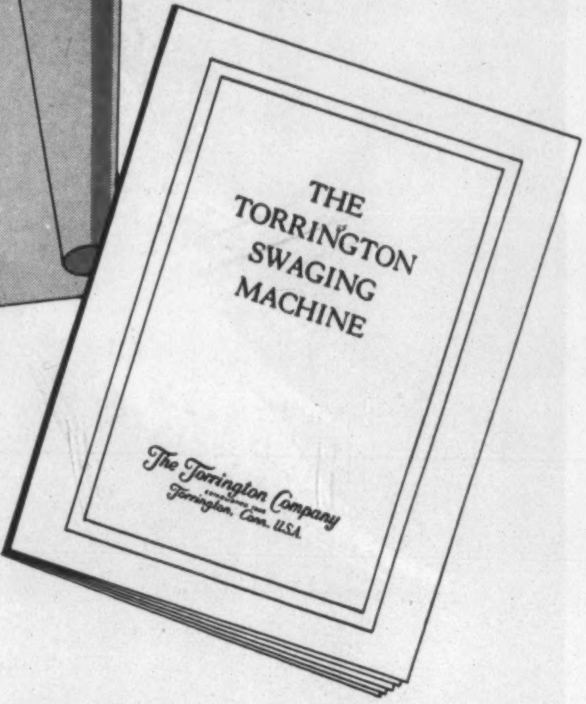
A. D. Schultz has been promoted to chief engineer of Eaton Manufacturing Co.'s Stamping Div.

Robert J. Levine has been appointed chief engineer, Edin Co., Inc.

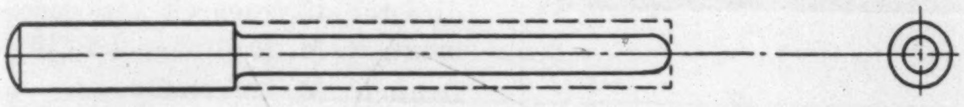
A. J. Kingseed has been advanced to assistant general manager, Farrell-Cheek Steel Co. Other promotions by the company include **F. A. Kingseed** to works manager, and **Alton Zimmerman,** assistant works manager.

Dr. James Marsden has been made manager of a new long-range Insulation Materials Study Project in General Electric Co.'s Chemical Development Department. In addition, the company has appointed **Robert W. Sullivan** as senior metals processing engi-

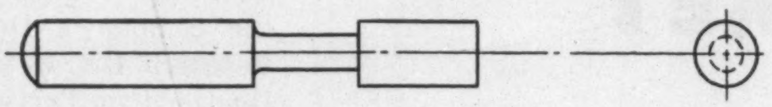
Swaging Success Stories



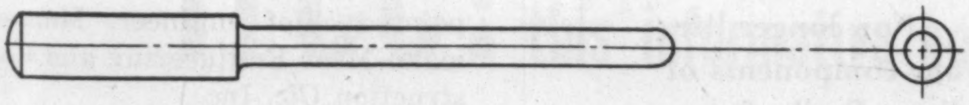
Close Tolerances... without Machining



This finished piece used to be made on an automatic screw machine with the long, narrow diameter section turned to .100 ±.003 and a necessary sharp shoulder.



Torrington's swaging experts suggested starting with this simple screw machine blank (to retain the required shoulder).

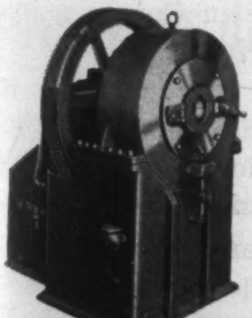


Result after one rotary swage—an improved finished piece, to a tolerance of ±.001.

Why not write for our informative booklet on swaging that includes complete descriptions of Torrington Rotary Swagers. It may show you how you can achieve a "swaging success story" in your own plant.

See what savings you can make by swaging

1. Saving in material—swaging uses nearly all the metal.
2. Saving in time—swaging is fast.
3. Saving in labor—unskilled labor can run a swager.
4. Saving in machining—swaging produces finishes accurate to ±.001.
5. Saving in finishing operations—swaging produces high finish, better hardness and resiliency.



THE TORRINGTON COMPANY
Swager Department
660 North Street, Torrington, Conn.
Makers of Torrington Needle Bearings

TORRINGTON ROTARY SWAGING MACHINES

For more information, turn to Reader Service Card, Circle No. 445

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New High-Temp Oxidation Resistance

NEWS YOU SHOULD KNOW . . . Now longer life, greater value can be derived from your components of mild steel, stainless steel, or other alloys. Easily flame-sprayed Metal Hydrides' new Cermet of nickel-magnesium oxide* resists high-temperature oxidation and provides low thermal conductivity and high-temperature erosion resistance.

Metal Hydrides' metallurgical engineers will be happy to give you more information, without obligation. Call, wire or write today.

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MH **Metal Hydrides**
INCORPORATED
1205 CONGRESS STREET, BEVERLY, MASSACHUSETTS

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neer, and has named **Carl A. Drake** as manager-manufacturing engineering unit, Laminated & Insulating Products Department.

Gilbert C. Gettelman has been promoted to chief development engineer, Geuder, Paeschke & Frey Co.

Robert L. Wolff has been elected vice president in charge of engineering, Centralab Div., Globe-Union Inc.

Wilkison W. Meeks has joined the staff of The B. F. Goodrich Co. Research Center as a senior technical man.

William P. Burke has been named general manager of Hokin Aluminum Co.'s aluminum extrusion plant in Dolton, Ill.

George F. Sharrard has been given the advanced position of director of research and development, R. M. Hollingshead Corp.

Branch M. McNeely, Jr., has joined the Development and Research Div. of The International Nickel Co., Inc., as a member of the Texas Technical Field Section.

E. M. Uebel and **K. H. Kirgin** have also become identified with the company's Development and Research Div. as members of the Ductile Iron Section.

Robert M. Van Tassel has been made head industrial designer, Joy Manufacturing Co.

Robert Hartenstein has been appointed chief engineer, Mannesmann-Meer Engineering and Construction Co., Inc.

Norbert L. Kopchinski has been added to the staff of the Nuclear Research & Development Div., The Glenn L. Martin Co., as a manufacturing engineer.

Bertrand Y. Auger has been named technical director, Reinforced Plastics Div., Minnesota Mining & Manufacturing Co.

Dr. Alan Franklin has been appointed to the staff of the National Bureau of Standards Porcelain and Pottery Section where he will conduct research on fundamental properties of ferroelectric materials. The Bureau, in addi-

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improve your product and cut your costs
Standard Steel Works Division
Burnham (Mifflin County), Pa.
BALDWIN-LIMA-HAMILTON

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When you consider a change in your product, you expect that change to make money for you or to save money for you.

It's quite possible that Standard Steel Forged Weldless Rings and Flanges will do *both*.

They improve your product, thus making your sales task a little easier, and they cut your manufacturing costs. In many cases, first cost may be less than the component you now use, and always machining time is less.

In checking through this detailed booklet, you'll be able to determine in five minutes or less whether they're worth investigating further. Send the coupon now.

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Baldwin-Lima-Hamilton Corporation, Burnham, Pa.

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Address__________

City__________ Zone_____ State_____

For more information, Circle No. 350

HOW PE "CREATIVE EXTRUSIONEERING" CAN HELP YOU CUT MANUFACTURING COSTS ... IMPROVE PRODUCT QUALITY

PE's Creative "Extrusioneering" is more than just a designing and mill service. It's an expanded assistance program designed to help you create new aluminum extrusion applications for your product . . . applications that will cut manufacturing costs and improve product quality. Because PE's staff of competent engineers have wide experience in all types of fabricating operations, they can provide invaluable aid in helping develop ideas that will, for example, reduce fabricating costs, simplify assembly, eliminate machining operations, and provide greater stability and strength. Why not call in a PE engineer without obligation and let him analyze your product for possible cost-cutting extrusion applications. PE aluminum extrusions are produced under the latest methods of scientific quality control . . . facilities are complete from billet casting to finished extrusion. PE specializes in the job of PRODUCING EXTRUSIONS ONLY . . . they do not fabricate, they do not manufacture any other product. Your inquiries receive personalized and confidential attention.

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Write today for free technical bulletin illustrating and describing PE services and advantages of the aluminum extrusion process.

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For more information, turn to Reader Service Card, Circle No. 461

news of | ENGINEERS

tion, appointed **Dr. Samuel Zerfoss** as chief of its Refractories Section, following the retirement of **R. A. Heindl.**

Dr. James H. Gardner has been advanced to technical assistant to the director of research, National Research Corp.

news of | COMPANIES

New plants, names, addresses

Burton Manufacturing Co. has moved into a new building at Colorado Ave. at 26th St., Santa Monica, Calif.

Chromalloy Corp. of New York has changed its name to Chromalloy Corp. and has moved its plant and offices to 450 Tarrytown Rd., White Plains, N. Y.

Marquardt Aircraft Co.'s Research Div. has moved to expanded quarters adjacent to the production and engineering plants in Van Nuys, Calif.

Thomas Industries Inc. has announced the opening of a new plant at Hopkinsville, Ky., which will be operated by its Moe Light Div.

Mergers, acquisitions

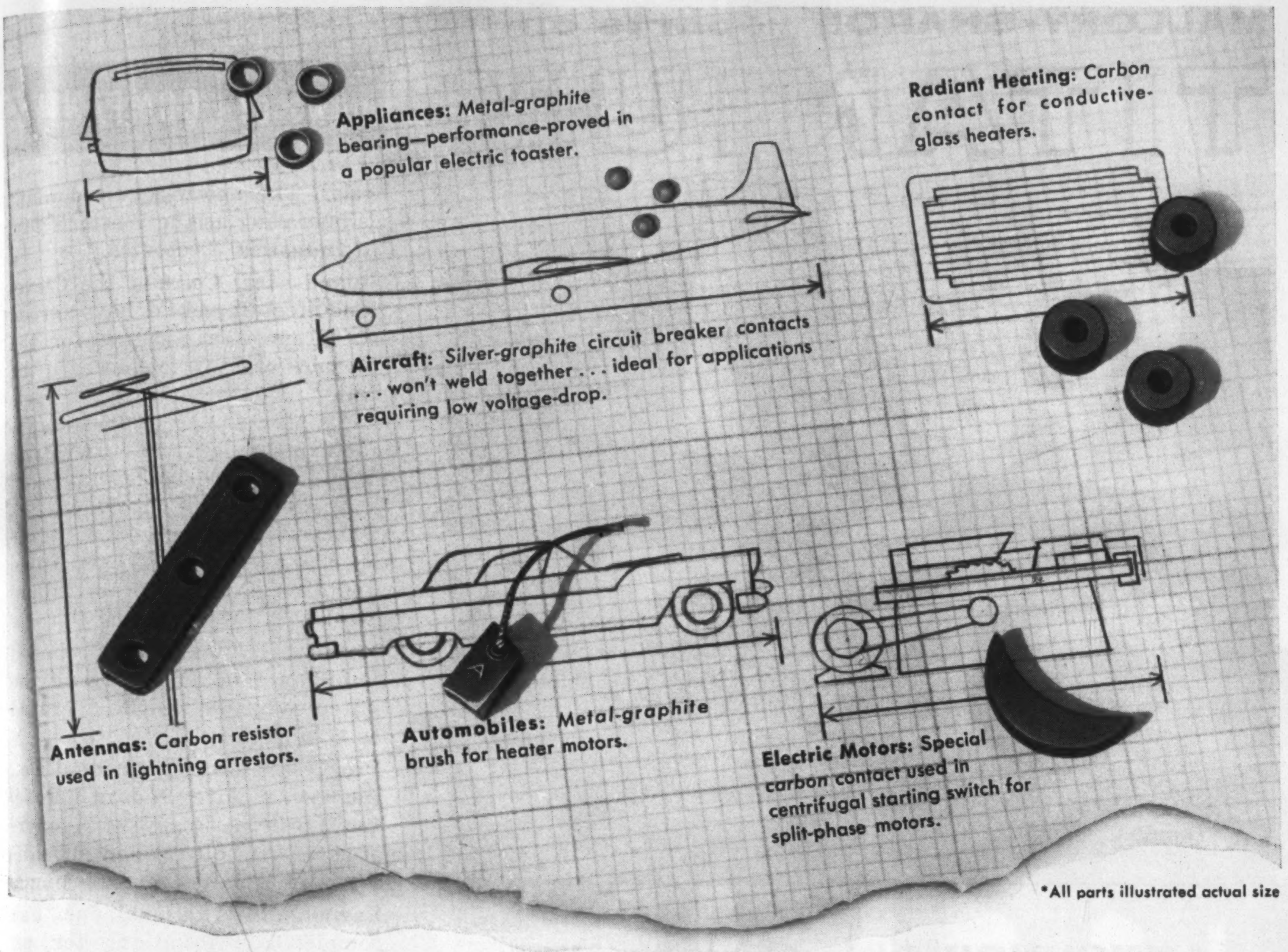
Beta Alloys Co. has been purchased by **Alcaloy, Inc.**

Consolidated Vacuum Corp., wholly-owned subsidiary of **Consolidated Engineering Corp.,** has been merged with the parent organization and will be known as the ConVac Div. of Consolidated.

Detroit Harvester Co. has purchased **Peters-Dalton Co.** The latter firm has become a wholly-owned subsidiary of Detroit Harvester and will retain its name.

Diamond Steel Co., Inc., has acquired the Foundry Bldg. at 5429 W. Roosevelt Rd., Chicago, and has moved its Flat Rolled Div. into the new location.

Industrial Tectonics, Inc., has announced the purchase of the manufacturing facilities of **Anti-Friction Bearings Co.,** Los An-


Appliances: Metal-graphite bearing—performance-proved in a popular electric toaster.
Radiant Heating: Carbon contact for conductive-glass heaters.
Aircraft: Silver-graphite circuit breaker contacts . . . won't weld together . . . ideal for applications requiring low voltage-drop.
Antennas: Carbon resistor used in lightning arrestors.
Automobiles: Metal-graphite brush for heater motors.
Electric Motors: Special carbon contact used in centrifugal starting switch for split-phase motors.

*All parts illustrated actual size

Drafting **new** *jobs for industry's most* **versatile** *material*

CARBONEERING by Speer

Why is carbon playing so many new roles in the latest product designs? Because designers are demanding exactly the *right* material these days. And very often, only carbon has *all* the properties they call for.

Consider the diverse applications of small carbon parts—such as those illustrated above. In each case, the designer needed a material with an unusual combination of physical properties. In these applications, and hundreds of others, *precision-molded* carbon parts by Speer filled the bill.

Carboneering might well be the route to that *right* material you're seeking. Let Speer's engineers and designers help you discover the advantages of carbon—for improved design and production economies.

You be the judge of carbon's versatility

Carbon can be:
- Sawed
- Drilled
- Milled
- Broached
- Turned
- Planed
- Hobbed
- Ground
- Molded
- Extruded

Carbon has:
- High corrosion resistance
- High heat transfer
- Low electrical resistance
- High thermal shock resistance

Carbon is:
- Not wetted by molten metals
- Non-warping
- Chemically inert
- Self-lubricating

SPEER Carbon Co.
St. Marys, Pennsylvania

For more information, turn to Reader Service Card, Circle No. 488

MALLORY·SHARON reports on

TITANIUM

FOR CERTIFICATIONS PURPOSES

	AVERAGE PROPERTIES	LIMITS
LONG. ULT. STRENGTH	87,300	±5,000
TRANS. ULT. STRENGTH	86,200	±5,000
LONG. YIELD STRENGTH	68,200	±5,000
TRANS. YIELD STRENGTH	70,400	±5,000
% ELONGATION	22.4	±2.3
SPREAD LONG.-YIELD to ULTIMATE	19,200	±3,500
SPREAD, TRANS.-YIELD to ULTIMATE	15,800	±3,000
BENDS 105° 4 TD LONG.	3TO T	
HARDNESS	56.5	
% RED. IN AREA		

ANNOUNCING . . . New quality certification cuts fabricating costs

● Mallory-Sharon now certifies physical properties of unalloyed titanium sheet within narrow limits, based on statistical quality control techniques. This policy has resulted in major savings in time, money, and forming equipment for titanium fabricators.

Here's how Mallory-Sharon's certification works: As a purchaser, you will order unalloyed titanium sheet with strength in a specified range (say 60,000 to 80,000 psi). In addition to meeting this specification, we advise you the average strength of material from each heat, and certify that 97.5% of the heat lies within narrow limits (such as plus or minus 5000 psi) of this value.

Since titanium of different strength levels requires different fabrication procedures, dies, etc., this certification means that you can eliminate testing and segregating titanium sheets into different strength levels, and eliminate multiple tooling set-ups.

Here is another first from Mallory-Sharon, leading producer of titanium and titanium alloys. For complete information, write Mallory-Sharon Titanium Corporation, Dept. G-12, Niles, Ohio.

MALLORY Ti SHARON

For more information, turn to Reader Service Card, Circle No. 441

news of | COMPANIES

geles. The newly-acquired plant is operating as the Western Div. of Industrial Tectonics.

Inland Steel Co. and the **Cleveland Steel Barrel Co.** have agreed on terms of a contract for the former company to purchase the Ohio manufacturer of barrels and pails. The principal manufacturing plant of Cleveland Steel Barrel Co. in Cleveland and a smaller plant in Greenville, Ohio, will be merged into the operations of the Inland Steel Container Co. division of Inland Steel Co.

Pheoll Mfg. Co. has purchased **Voi-Shan Mfg. Co. Inc.,** and the latter company will be operated as a subsidiary of Pheoll.

Progress Manufacturing Co., Inc., has acquired **Judson & Rose, Inc.** Judson & Rose will be operated as a wholly-owned subsidiary, retaining its corporate name.

Reynolds International, Inc., has completed negotiations for an aluminum sheet and foil plant at Cap-de-la-Madeline in Quebec, Canada. Reynolds Aluminum Co. of Canada, Ltd., will be formed to operate the plant, formerly operated by **Aluminum Rolling Mills, Ltd.**

news of | SOCIETIES

The **American Institute of Consulting Engineers** has selected Benjamin F. Fairless, chairman of the Executive Advisory Committee, U. S. Steel Corp., as the 1955 recipient of the annual Award of Merit.

The **American Iron and Steel Institute** has received the 1955 Presteel Award in honor of its role in enlarging the field of metal stamping with its continual program of education, research and materials improvement. The award is sponsored each year by the Worcester Pressed Steel Co. in association with the Pressed Metal Institute.

(Continued on p. 224)

HERE ARE THE FASTENERS YOU NEED

Do you use large fasteners? Small fasteners? Long or short fasteners? Bethlehem makes them all! We turn out headed-and-threaded items in hundreds of types and sizes, making it easy for you to get exactly what you require. Bethlehem Bolts and other fasteners are made from good sound steel by men with long experience in fastener-manufacture. For a satisfactory bolting job, you can count on Bethlehem fasteners every time.

Bethlehem Bolts Are Good Bolts

BETHLEHEM STEEL

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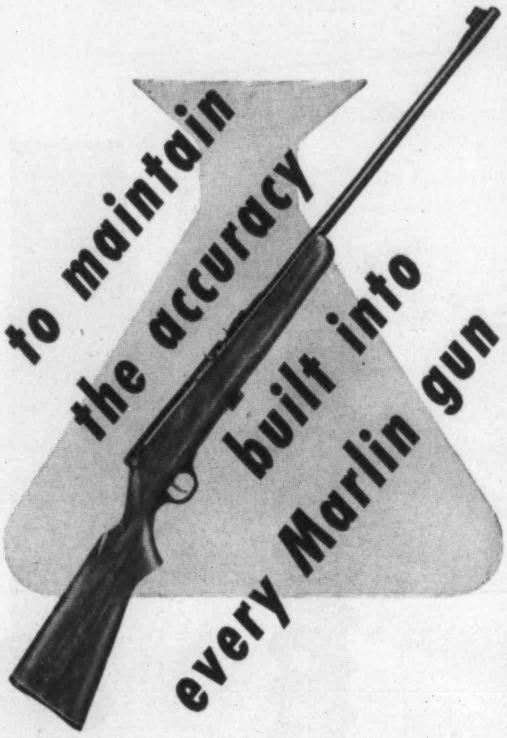
Du-Lite FINISHED



The Marlin Firearms Co., "Famous for Fine Guns since 1870", has long depended on Du-Lite black oxide for an attractive finish that will be dimensionally stable throughout the life of the gun.

The Du-Lite process provides intricate precision parts with a durable, rust-resistant black oxide finish. And since Du-Lite penetrates the metal, all crevices and knurls are protected without affecting dimensions or fit.

If your target is durable, attractive, economical finishing, you'll want to know more about Du-Lite black oxide.

Whatever your cleaning or finishing problem—**Depend on Du-Lite.**

Write for complete information.

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MIDDLETOWN, CONN.
Send more information on Du-Lite............ ☐
Send information on metal finishing products.. ☐
Have your representative call.............. ☐
Name.........................
Company.........................
Address.........................
City.................. Zone....... State..........
4

Du-Lite
METAL FINISHING SPECIALISTS

For more information, Circle No. 383

news of | SOCIETIES

The **American Society for Metals** has awarded its 1955 Gold Medal to Alfred L. Boegehold, assistant to the vice president in charge of General Motors Corp.'s Research Staff, "in recognition of his great versatility in applying science to the metal industry."

In addition, the Society has presented two of its highest awards to three Crucible Steel Co. of America scientists. Peter Payson, assistant director of Research and Development for Crucible, was named Campbell Memorial Lecturer for 1958 by the Society's Board of Trustees on the basis of his outstanding ability and many contributions to the metallurgical field. A. E. Nehrenberg, supervisor of Crucible's Tool and Die Steel and Structural Steels Research, and Peter Lillys, a Crucible research metallurgist, were awarded the Howe Medal for their paper, "High Temperature Transformations in Ferritic Stainless Steels Containing 17 to 25% Chromium." The paper was one of 71 technical papers appearing in the Society's publication, *Transactions*, during 1954.

The **American Society of Mechanical Engineers** and the **American Society for Testing Materials** have received a grant from the Engineering Foundation for the 1955-1956 fiscal year to further their joint project on the Effect of Temperature on the Properties of Metals.

The **Gas Appliance Manufacturers Assn.**, during the National Metal Congress and Exposition in Philadelphia, honored the late Adolph W. Machlet, who was chairman of the board of American Gas Furnace Co. and president and treasurer of the subsidiary American Metal Treatment Co. Mr. Machlet was awarded the distinguished service award of the Industrial Div. of the Association. The citation was accepted by P. C. Osterman, president of American Gas Furnace Co.

(Meetings & Expositions on p. 226)

Find Out Why You Get

Freedom from . . .
1 Porosity
2 High Cost Material
3 Expensive Machining
4 Metallurgical Variation

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PERMANENT MOLD
Gray Iron Castings

Write NOW for Our Illustrated Brochure

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Permanent Mold Gray Iron Castings by DOSTAL offer many advantages. Their structure is uniform and surface scale is eliminated. These 2 factors permit higher speed machining with faster feeds. The dimensional accuracy and uniformity of DOSTAL Permanent Mold Castings reduces machining operations to a minimum. Permanent molded castings are uniform in hardness and their structure is dense and porous-free.

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AVAILABLE TO COMPANIES INTERESTED IN Corrosion Control

How
Zinc
CONTROLS
CORROSION
CORRO
METALLIC ZINC COATINGS
ZINC PIGMENTS
ZINC ANODES

$6,000,000,000

. . . That's the nation's annual bill for corrosion

How much of it is your share?

Corrosion is an expensive headache. Experts state that damage from rust in the United States amounts to $6 billion a year!

Top management is determined to control corrosion to avoid mounting maintenance and replacement costs. Equipment failure due to corrosion, resulting in extensive shutdown of operations and loss of valuable production, must be prevented.

This booklet presents important information for management, maintenance engineers, architects and everybody concerned with minimizing corrosion and maintenance costs. Suggestions for prolonging the life of metallic structures are to be found in the text and illustrations which follow. Here is evidence that a sound corrosion-prevention program based upon the use of zinc will lengthen the life of steel products, slash maintenance costs and increase net earnings.

MUCH IS BEING DONE TO COMBAT CORROSION . . .

For specific plant equipment, special alloys involving nickel, copper, chromium and other elements have been developed to withstand highly corrosive conditions. Such alloys are expensive, but the service they perform justifies their high cost. Operations at today's high levels, which must be speedy and sustained, would be difficult without them.

BUT . . .

While millions of tons of steel are given zinc protection each year, a large tonnage of steel used for less demanding purposes which could be protected at modest cost is given no treatment at all or merely temporary protection.

"How Zinc Controls Corrosion" is a 32-page, 8½ x 11" illustrated booklet which has just been published by the American Zinc Insitute — of which this company is a member. It presents factual evidence that a sound corrosion-prevention program based upon the use of zinc in its various forms will lengthen the life of iron and steel products and slash maintenance costs of steel structures — be they above ground, buried underground or submerged in fresh or sea water. Although zinc — either as a protective metallic coating, as a paint or as a sacrificial anode — has a long record of successful performance for this purpose, products, techniques and controls are continually being improved in the zinc and galvanizing industries. Hence, there is much new information which should be in the hands of those who could profit by it. This information is yours for the asking.

Copies of "How Zinc Controls Corrosion" may be obtained by writing to

ST. JOSEPH LEAD COMPANY

250 PARK AVENUE, NEW YORK 17, N. Y.

more important
NEW DEVELOPMENTS
from
THE CHEMICAL
CORPORATION
Research Laboratory

LUSTER-ON® OLIVE DRAB N. D.

A dark, hard, stable olive drab coating. Applied in about 15 seconds at room temperature. Gives maximum corrosion protection. Meets most rigid specifications. Available in one package.

LUSTER-ON D

A powdered product to produce a bright clear conversion coating on zinc and cadmium.

LUSTER-ON ACTIVATOR

Designed for preparing a zinc alloy die casting prior to treatment in our Luster-On acid baths. Also serves as a mild cleaner. However, heavy soil must be handled by a precleaner.

LUSTER-ON NS

The answer to "spotting out" troubles on thin copper and brass plate, especially under humid conditions. Improves adhesion, provides leveling action, saves lacquer. Eliminates fingerprints before assembly.

LUSTER-ON ALUMINUM SEALER (222-M)

Produces a chromate film on aluminum that provides excellent corrosion protection and can serve as a paint base. Now can be dyed in many attractive pastel colors. Meets requirements of Government Spec. MIL-C-5541.

•

Ask for literature. Send a sample for free laboratory treatment.

Luster-On products are manufactured on the West Coast by Crown Chemical and Engineering Company of Los Angeles, Calif., and in the Dominion of Canada by Alloycraft Limited of Montreal, Quebec.

You'll also be interested in our Safety Division's line of industrial skin cleaners and protectors . . . protect your workers and your products. Literature available.

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67 WALTHAM AVENUE
SPRINGFIELD, MASS.

For more information, Circle No. 436

Meetings and Expositions

SOCIETY OF AUTOMOTIVE ENGINEERS, annual meeting. Detroit. Jan. 9-13, 1956.

SOCIETY OF PLASTICS ENGINEERS, annual conference. Cleveland. Jan. 18-20, 1956.

MALLEABLE FOUNDERS' SOCIETY, general meeting. Cleveland. Jan. 20, 1956.

SOCIETY OF THE PLASTICS INDUSTRY, Annual Reinforced Plastics Div. Conference. Atlantic City, N. J. Feb. 7-9, 1956.

AMERICAN INSTITUTE OF MINING & METALLURICAL ENGINEERS, annual meeting. New York. Feb. 20-23, 1956.

AMERICAN SOCIETY FOR TESTING MATERIALS, committee week. Buffalo, N. Y. Feb. 27-Mar. 2, 1956.

SOCIETY OF AUTOMOTIVE ENGINEERS, passenger car, body and materials meeting. Detroit. Mar. 6-8, 1956.

NATIONAL ASSN. OF CORROSION ENGINEERS, annual conference and exhibition. New York. Mar. 12-16, 1956.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Aviation Div. Conference. Los Angeles. Mar. 14-16, 1956.

STEEL FOUNDERS' SOCIETY OF AMERICA, annual meeting. Chicago. Mar. 18-20, 1956.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, spring meeting. Portland, Ore. Mar. 18-21, 1956.

SOCIETY OF AUTOMOTIVE ENGINEERS, national production meeting and forum. Cleveland. Mar. 19-21, 1956.

AMERICAN SOCIETY OF TOOL ENGINEERS, industrial exposition. Chicago. Mar. 19-23, 1956.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Instruments and Regulators Div. Conference. Princeton, N. J. Mar. 26-27, 1956.

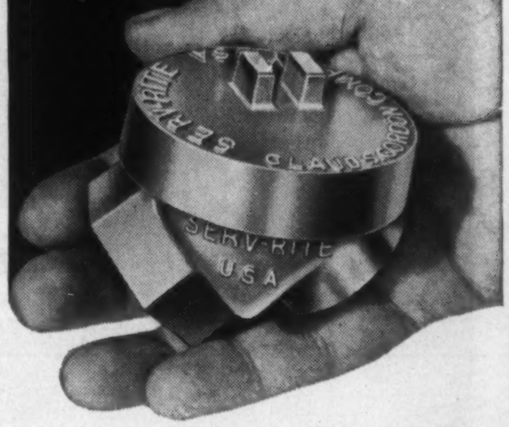
SOCIETY OF AUTOMOTIVE ENGINEERS, aeronautic meeting, aeronautic production forum and aircraft engineering display. New York. Apr. 9-12, 1956.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Machine Design Div. Conference. Worcester, Mass. Apr. 10-11, 1956.

AMERICAN WELDING SOCIETY, national spring meeting and 4th welding and allied industry exposition. Buffalo, N. Y. May 8-11, 1956.

DESIGN ENGINEERING SHOW, exposition and conference. Philadelphia. May 14-17, 1956.

"SERV-RITE"
THERMOCOUPLE
HEAD



the head that's ahead in every way . . .

This new "Serv-Rite" thermocouple head is actually small enough to be held comfortably in the palm of your hand. But size is only one of the many features that make this thermocouple head really extraordinary. It is loaded with installation and service conveniences that any user of thermocouples will appreciate at once.

The body is of malleable iron, cadmium plated for durability. A new type friction lock assures easy removal or tightening of the cap — a quarter turn does it. An asbestos gasket makes the head dirt- and moisture-proof. With a choice of 1/2", 3/4", or 1" IPS opening for the protecting tube, you can standardize on one style head.

The connector block is of a material especially selected to withstand, without damage, temperatures up to 900° F. in continuous service. Improvements over the conventional type of inserts greatly simplify the making of the lead wire connections. The complete thermocouple element, including connector block, can be easily withdrawn for inspection.

Install a "Serv-Rite" thermocouple head and see for yourself how much better it really is.

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When casting instrument housings
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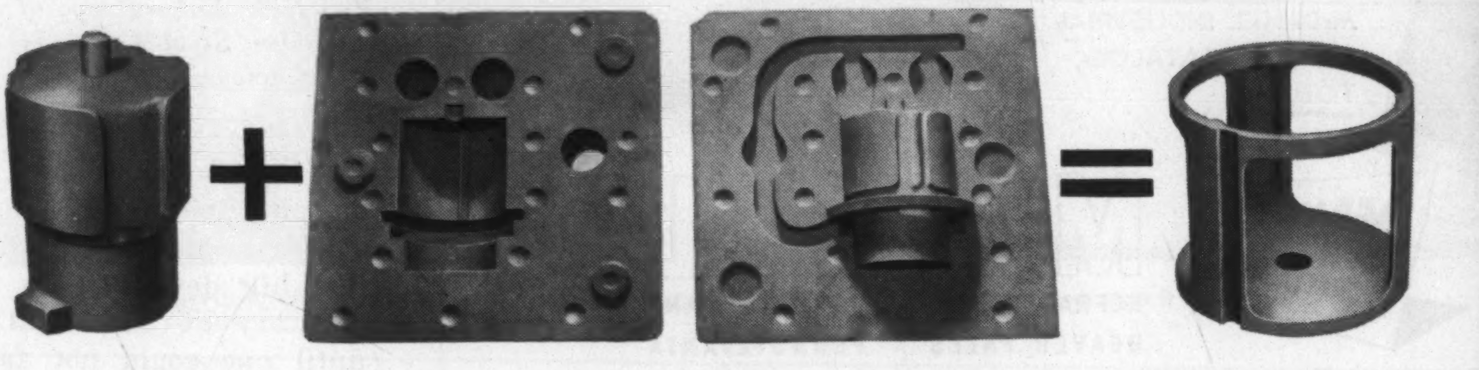

SHELL CORE SHELL MOLD INSTRUMENT HOUSING

Maintaining close dimensional accuracy, fine surface finish and uniform soundness in casting this 1¼ pound stainless steel instrument housing, demanded design conferences with the customer, "tailored" pattern equipment, hand rammed hollow shell cores, closely controlled pouring range, Shellcast® know-how, and special handling methods from shakeout to shipment.

Here is another factual story of casting to standards formerly considered impossible . . . thanks to Cooper Alloy *Advanced Know-How*. To find out how AKH made the difference in the production of these instrument housings write for case study #3.

Foundry Products Division

COOPER ALLOY
CORPORATION • HILLSIDE, N.J.

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For more information, turn to Reader Service Card, Circle No. 338

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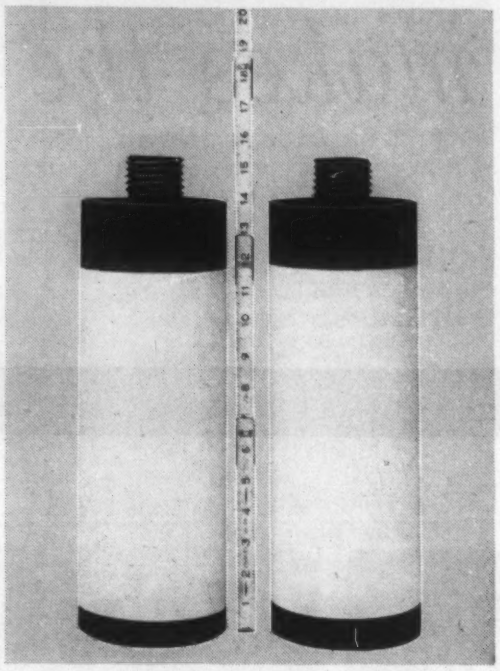

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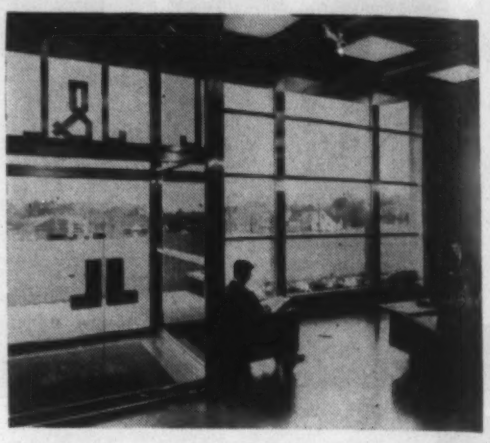
MATERIALS ENGINEERING NEWS

(Continued from p. 13)



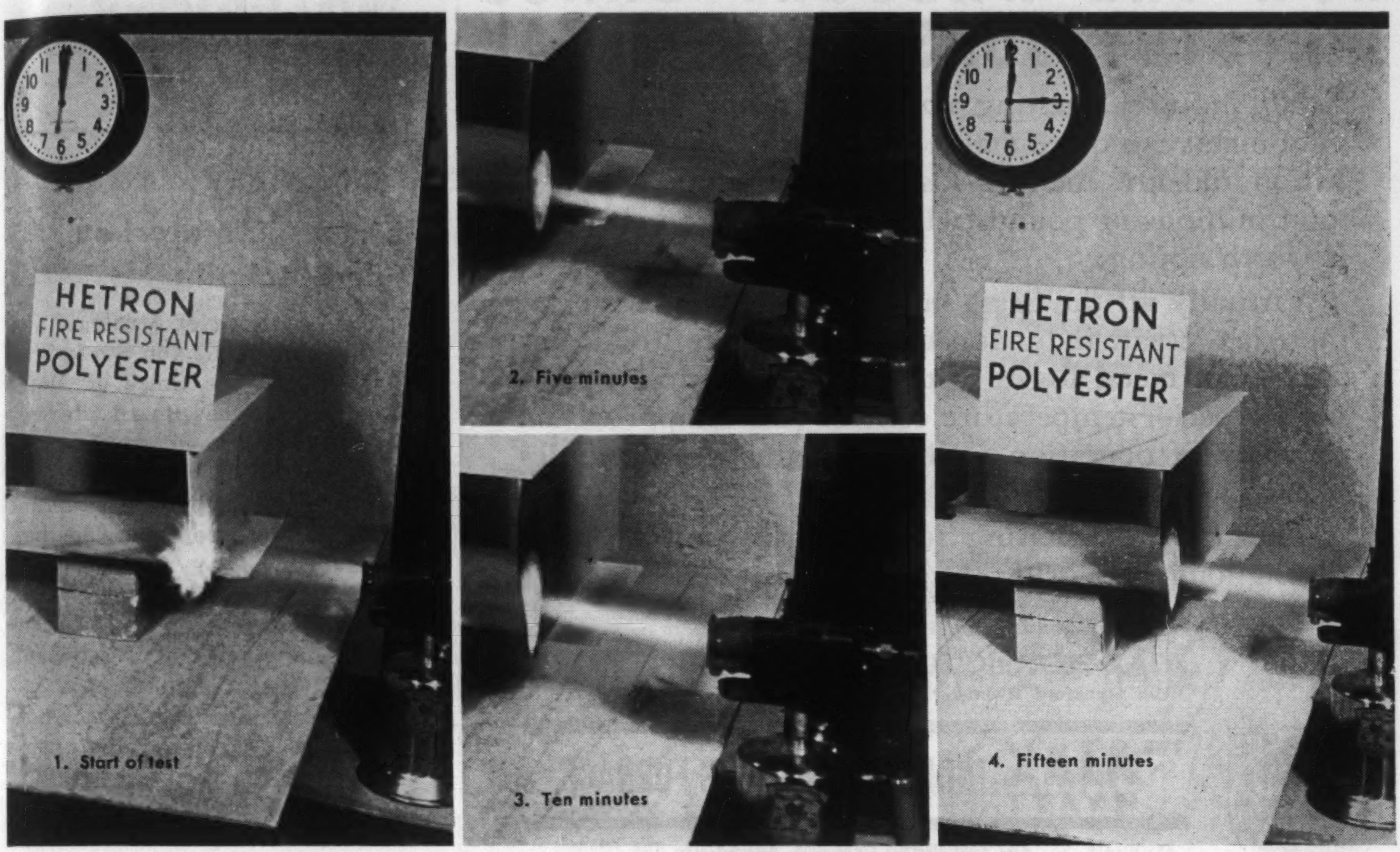
Lobby *in the new $1,500,000 Graham Research Laboratory of Jones & Laughlin Steel Corp. is attractive and spacious.*

the pilot plant and on a commercial scale. . . . The history of most big developments is really a history of successful failures (until one could not fail to be successful).

"In order to put the increased knowledge of our processes to full use, it will be essential that we develop a better understanding of the scale-up factors that will permit the reliabie extrapolation of data from small highly flexible research units to the massive installations in our plants. Probably no single factor restricts the useful application of new basic knowledge as much as our inability at this time to project the results of laboratory data in large scale application with satisfactory reliability."

Dr. Turner continued, "With no let-up in the technical effort that we have aimed toward our customers' needs, we expect in J&L to broaden and intensify that area of our research effort which is directed toward cost and quality improvement in our basic processing steps. We see this as essential since the steel industry is under heavy competitive pressure not only within its own family, but from without—from lighter metals and plastics."

(More News on p. 230)



1. Start of test

2. Five minutes

3. Ten minutes

4. Fifteen minutes

BLOWTORCH FLAME plays steadily on HETRON test structure for 15 minutes; can't start it burning.

New material for idea-men: fire-resistant polyesters

Want to engineer high strength plus *specific fire resistance* into a product? Take a hard look at HETRON® polyester resins.

You can use HETRON in many places where reinforced polyesters have not been practical heretofore. HETRON will not burn, except at the point where a hot flame is directly applied. It "snuffs out" as soon as the flame source is removed.

In exploratory tests, sheets of HETRON have shown flame spreads as low as 20 by ASTM E84-50T (Tunnel Test)—compared with ratings of 0 for asbestos board and 100 for red oak.

The versatile "family" of HETRON resins can be modified and blended by the fabricator, to make possible a whole galaxy of controlled physical properties. These resins combine fire resistance with outstanding flexural strength, tensile strength, heat resistance, and very low water absorption. Using light-stabilized HETRON, you can attain excellent resistance to weathering.

Some HETRON resins, including semi-rigid HETRON 32A, are manufactured to meet Military Aircraft Specification MIL-R-7575A, Types I and II. HETRON 92, with up to 10% added styrene, meets MIL-R-7575A, Types I, II, III.

New as it is, HETRON is already proving its merit in automobile and truck body panels and structural members; aircraft parts; large boat hulls; machine housings; radomes; electrical insulating board and parts; chemically resistant blowers, tanks and ductwork; "sandwich" structural and refrigeration panels; skylights, louvers, and industrial windows.

Is there a place in your designs for this unique combination of strength-plus-safety? To find out, write today for complete data file on HETRON resins. Ask also for names of fabricators who can supply you with HETRON parts.

Comparative Physical Characteristics

HETRON and 10 non-fire-resistant resins

Physical Property		Rigid Resins		Semi-rigid Resins
		HETRON 92	Avg. 10 Others	**HETRON 32 A**
Flexural Strength, PSIx10³	Room Temp.	**38.6**	36.4	**41.8**
	180°F.	**25.0**	18.6	**23.5**
Flexural Modulus, PSIx10⁶	Room Temp.	**1.88**	1.61	**1.82**
	180°F.	**0.90**	0.79	**0.85**
Tensile Strength, PSIx10³		**21.7**	22.0	**21.0**
Water Absorption, Pct. by Wt.		**0.13**	0.29	**0.13**

SUPERIOR PHYSICALS of HETRON show up in exhaustive tests by independent, impartial laboratories. Panels 0.1" thick, made from HETRON and 10 leading non-fire-resistant resins, contained 35-40% glass mat, 17-20% filler, and the balance resin. Note that HETRON 32A, a semi-rigid resin, is compared with non-fire-resistant *rigid* resins.

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HOW THE WROUGHT BRASS INDUSTRY CONSERVES METAL

No industry melting *commensurate tonnage** of vital metal can quite match the brass mills for conservation and low melting losses. The savings of metal total millions of pounds; clearly the method they use is worth noting:

Virtually all the brass mills in North America use the Ajax-Wyatt induction melting furnace, for it has the lowest metal losses in the field—less than 1%—with superior temperature control and unapproached economy of operation on high production schedules such as we have today.

The accepted melting tool in brass rolling mills throughout the world.

* *Upwards of 5 billion pounds annually.*

AJAX ELECTRIC FURNACE CORP.
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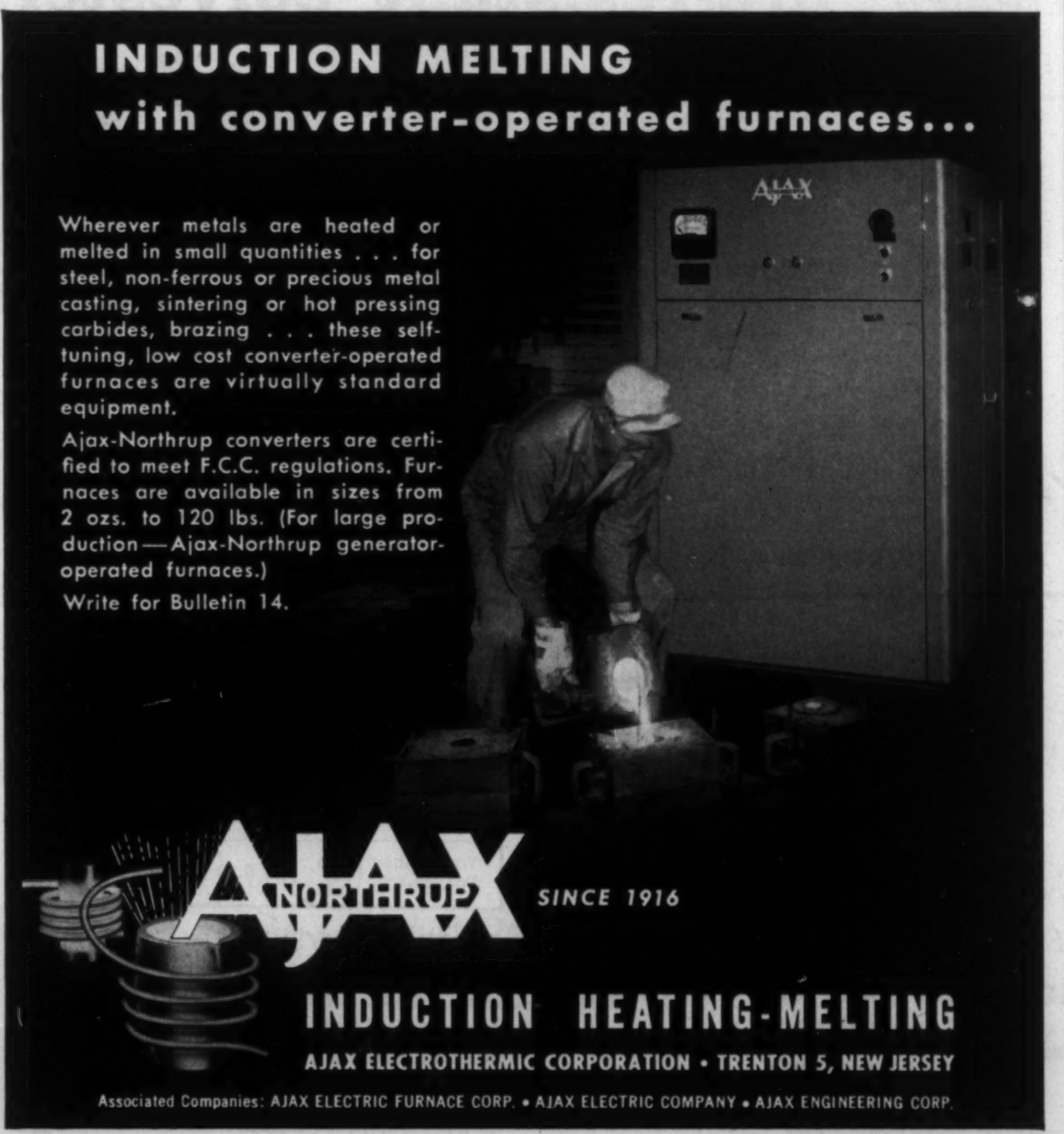
AEF CORP

THE AJAX WYATT INDUCTION MELTING FURNACE

ASSOCIATE COMPANIES: Ajax Electrothermic Corporation, Ajax-Northrup High Frequency Induction Furnaces
Ajax Electric Company, Inc. The Ajax-Hultgren Electric Salt Bath Furnace
Ajax Engineering Corporation, Ajax-Tama-Wyatt Aluminum Melting Induction Furnaces



INDUCTION MELTING
with converter-operated furnaces...

Wherever metals are heated or melted in small quantities . . . for steel, non-ferrous or precious metal casting, sintering or hot pressing carbides, brazing . . . these self-tuning, low cost converter-operated furnaces are virtually standard equipment.

Ajax-Northrup converters are certified to meet F.C.C. regulations. Furnaces are available in sizes from 2 ozs. to 120 lbs. (For large production—Ajax-Northrup generator-operated furnaces.)

Write for Bulletin 14.

AJAX NORTHRUP SINCE 1916

INDUCTION HEATING-MELTING

AJAX ELECTROTHERMIC CORPORATION • TRENTON 5, NEW JERSEY

Associated Companies: AJAX ELECTRIC FURNACE CORP. • AJAX ELECTRIC COMPANY • AJAX ENGINEERING CORP.

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MATERIALS ENGINEERING NEWS

Strategic Materials For Stockpile

The latest list of Strategic and Critical Materials for Stockpiling prepared by the Office of Materials, Munitions Board, reveals that the government considers 55 basic materials to be in sufficiently short supply to warrant a stockpiling program. The list, enumerating the uses, sources, and substitutes for strategic materials, contains only five for which the U. S. is self sufficient. These five are: aluminum, aluminum oxide, magnesium, molybdenum, and sapphire and ruby. Eighteen of the materials are produced in the United States but in insufficient quantities to meet the nation's entire industrial needs.

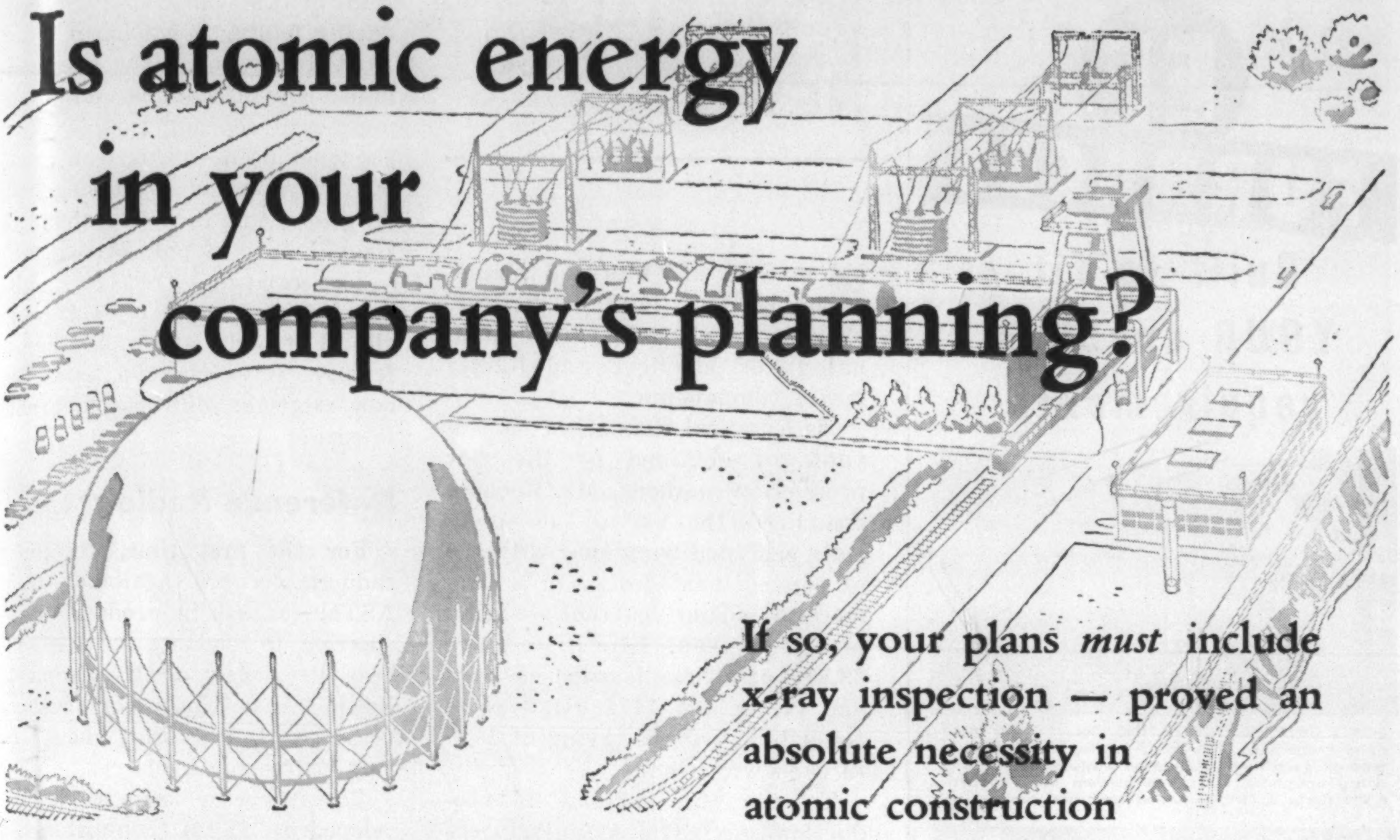
For thirty-two materials, including such basics as nickel, split mica, tantalum, chromium, cobalt, tin, antimony, beryllium, and industrial diamonds, this country is almost or wholly dependent on imports.

The Big Stretch

The world's largest aluminum plate stretcher at Kaiser Aluminum & Chemical Corp.'s Trentwood, Washington, rolling mill is being doubled in power to 10,000,000 lb and a second stretcher of 5,000,000 lb is being installed.

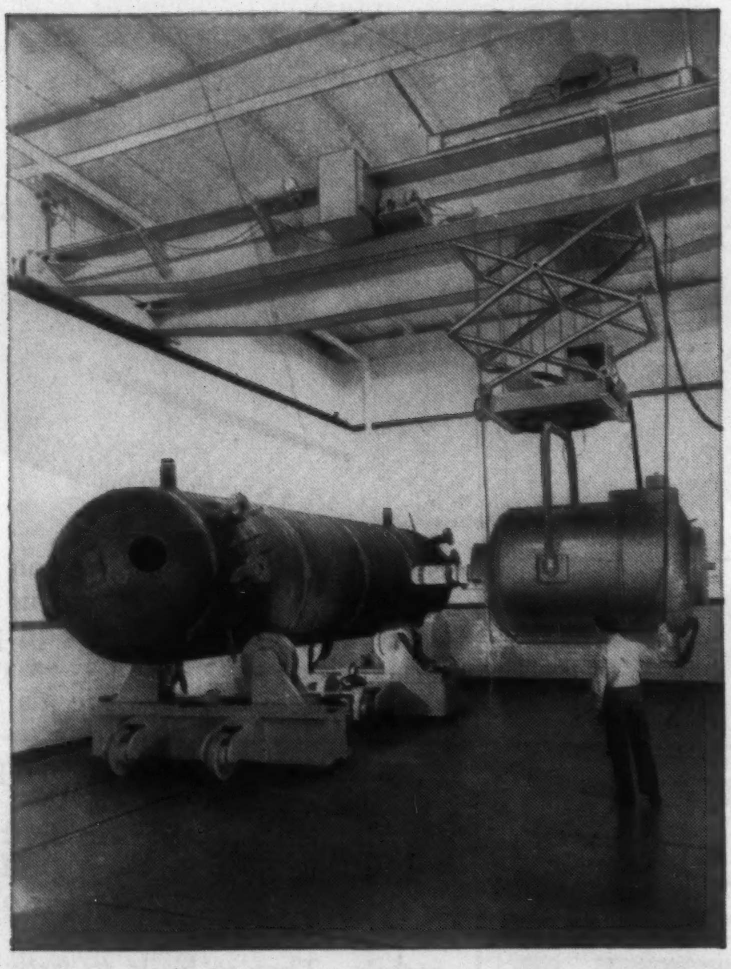
In making the announcement, D. A. Rhoades, the company's vice president and general manager, said that the additional facilities are being added to enable Kaiser Aluminum to provide the aircraft industry with a greater supply of critically needed stress-relieved aluminum alloy plate.

A large portion of today's airframe components have integral skin and structural members machined from large single pieces of heavy aluminum plate. The



Is atomic energy in your company's planning?

If so, your plans *must* include x-ray inspection — proved an absolute necessity in atomic construction



This 2,000,000-volt Resotron 2000 is typical of General Electric x-ray units now serving the atomic industry.

General Electric is presently supplying more x-ray equipment to atomic energy programs than to any other single industry — with good reason. Here, where failure cannot be tolerated, x-ray inspection is the *only* method which provides visible proof of the soundness of components and materials used in nuclear construction.

With the industry's widest experience in high-voltage x-ray — with more than one hundred super-voltage installations — General Electric is a natural choice whenever x-ray equipment is specified in this fast-growing field.

At the very start of your atomic energy planning, consult General Electric for both needed apparatus and necessary application experience. Our representatives are fully prepared to help you work with the atom.

• • •

High-voltage x-ray inspection for quality control is just one of the ways G.E. applies x-ray and related radiation to industry. If you have a non-destructive testing or inspection problem, contact your nearest G-E x-ray representative or write X-Ray Department, General Electric Company, Milwaukee 1, Wisconsin, for Pub. AZ-124.

Progress Is Our Most Important Product

GENERAL ELECTRIC

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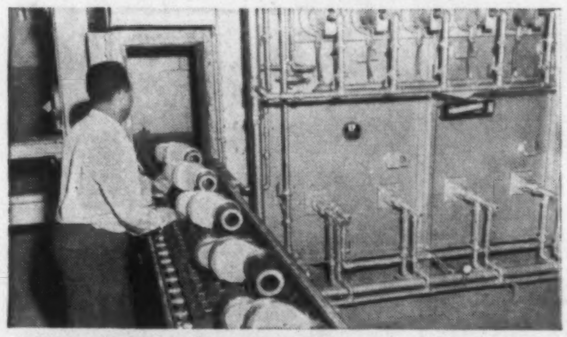
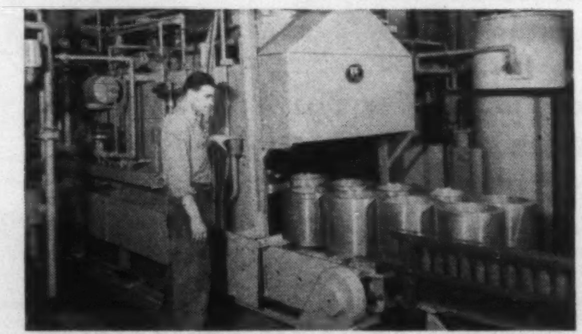
FURNACES
Built to fit
YOUR specific
requirements


SCALE FREE HEAT TREATING. This EF gas fired radiant tube installation with 3 heating zones, elevator type oil quench and a 2-station washing machine and rinsing equipment, scale free hardens heavy aircraft motor parts, uniformly, automatically and continuously.


UNIFORM ANNEALING. Brass, copper, aluminum, high and low carbon, stainless and other alloy strip, tubing and wire in coils, on reels or in strands, are uniformly annealed in hundreds of EF continuous and batch type furnaces. Our extensive experience can save you time and money.

BRIGHT ANNEALING. Discharge end of an EF gas fired radiant tube installation with EF endothermic special atmosphere generator for bright annealing various sizes of stampings, uniformly and continuously. Other EF installations are handling stainless steel and other stampings.

BULLETIN No. 461
shows typical installations
of EF Gas-fired, Oil-fired
and Electric Furnaces
Send for a copy today!

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GAS-FIRED, OIL-FIRED AND ELECTRIC FURNACES
FOR ANY PROCESS, PRODUCT OR PRODUCTION
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MATERIALS ENGINEERING NEWS

old method of "bits and pieces" assembly by joining separate shapes and sheet has been eliminated for stronger and lighter major components.

As a typical example of the advantages obtained by the new production methods, Mr. Rhoades compared the use of an integrally stiffened wing spar with one of conventional design in a commercial plane currently being manufactured. Eliminated are 33,776 attachments such as bolts and rivets and 1472 detail parts for a total weight saving of 17% in each wing spar.

To use this method of production, airframe manufacturers require exceptionally high quality aluminum plate which has had "locked-in" stresses literally stretched out to prevent distortion of the finished component during milling operations.

At Trentwood, slabs of aluminum alloy in combinations of dimensions—depending on alloy and stretcher used—up to 4 in. thick, 100 in. wide and 50 ft long, will be grasped at each end and 5 to 10 million lb of pull exerted.

The existing stretcher to be doubled in strength is 81 ft overall, 18 ft wide, and more than 9 ft high. It weighs 275 tons. The new stretcher will be comparable in size.

Reference Radiographs

For the first time, reference radiographs are available from ASTM for use in production inspection to evaluate weld soundness. Previously ASME standards specifically developed for pressure vessel work had been about the only source for industry.

The reference radiographs developed by ASTM Committee E-7 on Non-Destructive Testing are intended to serve as a guide for interpretation. No attempt has been made to establish limits of

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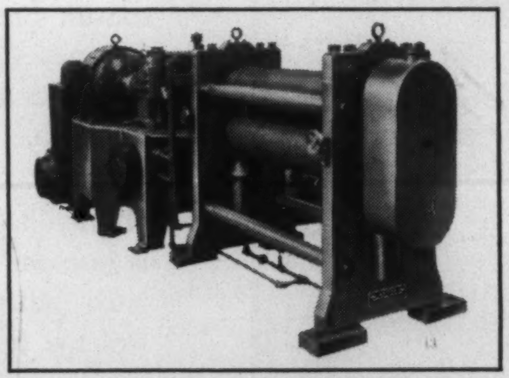
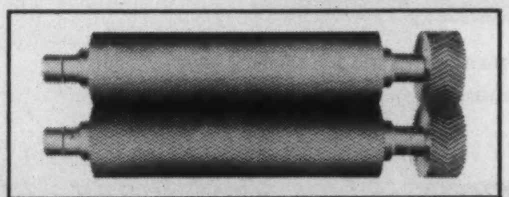
ROTARY EMBOSSING

Sheet, strip or coil takes on a new three-dimensional glamour when embossed on MEMCO equipment. Embossing the MEMCO way adds structural strength, conceals surface imperfections, permits the use of lighter gauges and increases product salability.
"MASTER" Hydraulic Embossing Machines and Engraved Matched Hardened Forged Steel Rolls are teamed to add high styling to all metals. They're built to provide day after day dependability and uniformity at speeds up to 1000 fpm. Your inquiry will bring you all the facts by return mail.

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Hillside 5, New Jersey

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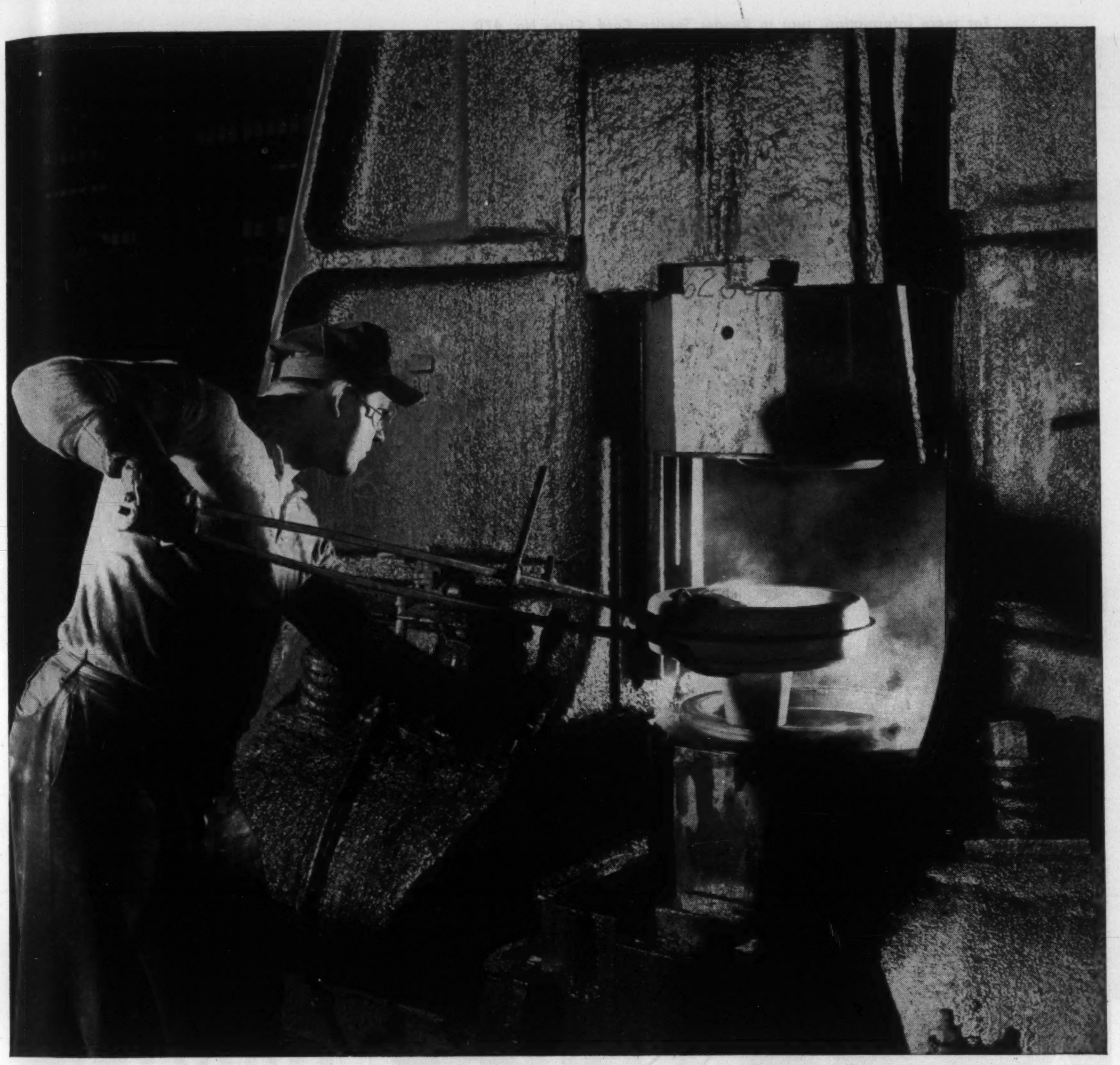

There's Never Any Question About a Bethlehem Drop Forging

You can be sure of top quality in a drop forging made by Bethlehem.

You can be sure that the steel is right, that the dies are right. You can be sure that the forging work is done conscientiously by men long skilled in their trade.

Bethlehem shops furnish an almost endless variety of designs for the oil, mining, aviation, automotive, electrical, and other industries. Both quality and variety are made possible by excellent facilities, which include modern die-sinking shops, steam and board drop hammers to 8,000 lb, mechanical presses to 3,000 tons, upsetters to 9 in., and full heat-treating equipment.

When you are figuring your next requirements for closed-die forgings, we'd appreciate the chance to talk with you. We offer excellent service, a first-class product, and competitive prices and deliveries.

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On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation

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from "impossible" to "in production"

with GRC die cast tiny parts

The unusual flexibility of Gries' die casting technique may answer your small parts problems. With almost unlimited design latitude, your designs—whether simple or complex—can be made exactly to your specifications, swiftly, accurately, economically. Cast in zinc alloy, in one automatic operation, completely trimmed! Let Gries' engineers solve your "impossible" problems.

FACT-FILLED BULLETIN — showing how Gries' ingenious, economical operations can solve your problems. *Send prints for quotation; write today for bulletin and samples.*

Quick delivery on quantities of 100,000 to many millions.
NO MINIMUM SIZE:
Maximum Weight: ½ oz.
Maximum Length: 1¾"

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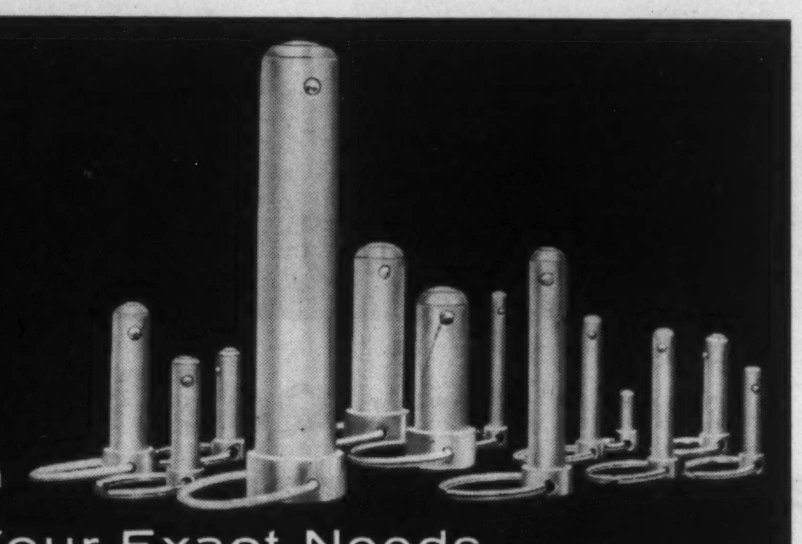
A Harley Lock Pin Will Fit Your Exact Needs...



Regardless of the size or depth of the opening, Harley Patents can supply you with a smooth fitting Lock Pin. Standard sizes range from ½" to 3" in length and in diameters from ¼" up.

Here is the finest Lock Pin available anywhere. For . . . remember, only a Harley Lock Pin has a solid steel shank at the points of stress. The exclusive silicone core and lock button are impervious to temperatures ranging from 100 to 500° F., weather, gasoline, alkalies and most acids. Because Harley Lock Pins are made to order, special design requirements can also be filled.

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MATERIALS ENGINEERING NEWS

acceptability for any discontinuity. For identification purposes each type of discontinuity is designated by a number. The degree of severity for each defect is indicated by a letter.

There are 35 radiographs in the form of transparencies mounted in standard 5x8 in. Keysort cards. The radiographs are reproduced from masters taken of official sample weld plates which are the property of ASTM. Details of plate, thickness, radiographic method, and welding procedure are given on each card. Provision has been made for expansion of the card file as new reference radiographs become available. The complete file of 35 radiographic transparencies can be purchased for $50 per set from ASTM Headquarters, 1916 Race Street, Philadelphia 3, Pa.

Superalloys in Quantity

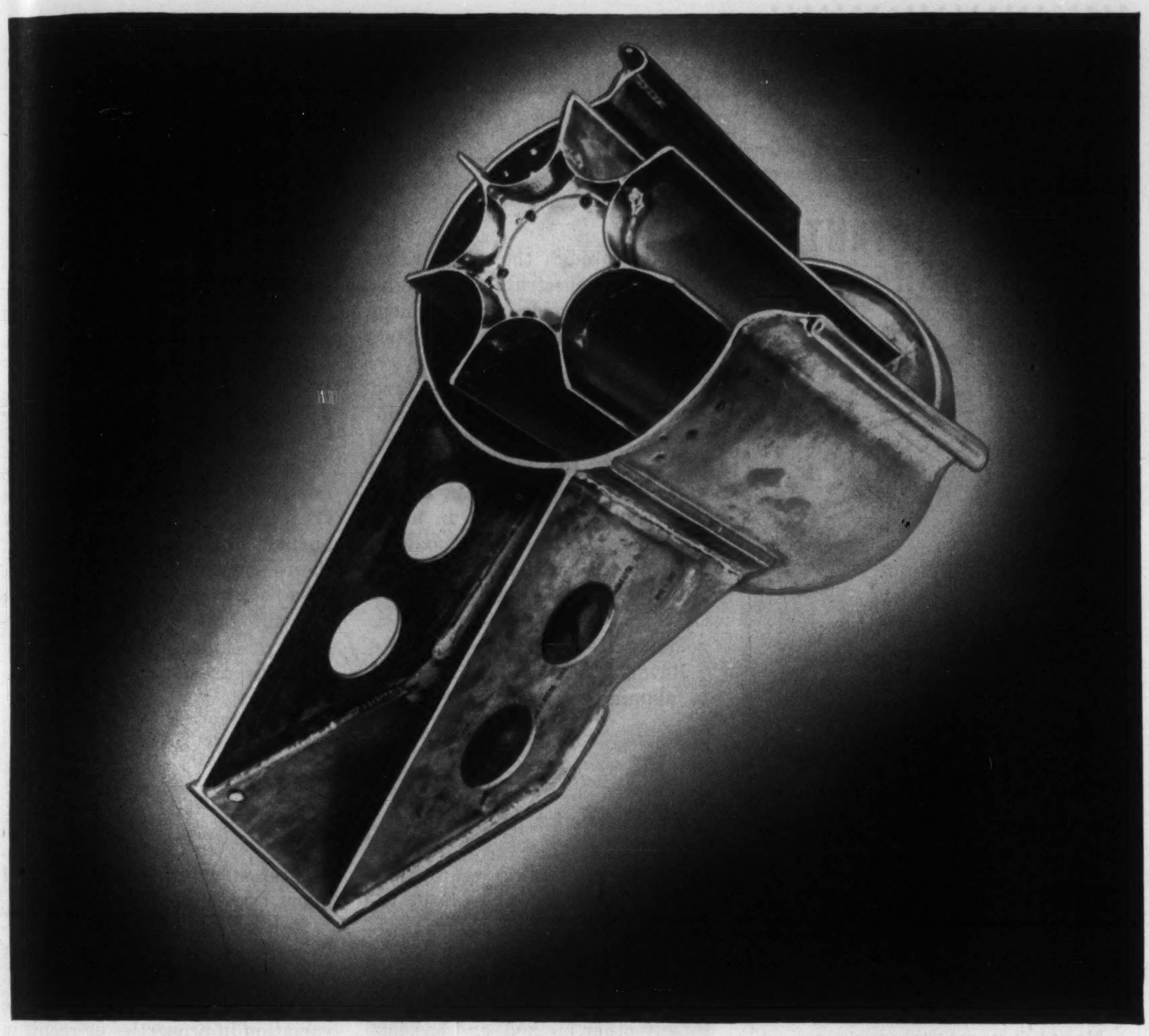
Consumable electrode vacuum melting facilities at Allegheny Ludlum Steel Corp. offer 250,000 lb per month of high performance alloys to industry.

Based upon anticipated industry needs, the melting department in Watervliet can make ten times more high quality superalloys than the whole industry has been using up to now.

Allegheny is offering consumable electrode vacuum remelted iron and nickel base superalloys, high speed steels, and certain stainless steels. The melting department was designed so that it can be expanded rapidly to four times its present size.

Rainbows on the Highways

Automobile stylists will find new freedom in handling metallic color with the transparent lacquers now available for aluminum. Tomorrow's cars will



TITANIUM cuts weight more than 50%...

Formerly made of steel, this magazine for a U. S. Navy gun mount weighed 198 pounds. Now, fabricated of REM-CRU A-70 *titanium* by Universal Match Corporation, this same part weighs only 95 pounds—*a weight saving of 103 pounds.* And due to the excellent fabrication characteristics of REM-CRU A-70, only minor design changes were necessary when production was shifted from steel to titanium.

Titanium's high strength-weight ratio may be just what you need, too. Or, perhaps more important to you, is titanium's exceptional resistance to most forms of corrosion. And remember—titanium can be machined, formed from sheet, forged or welded by normal shop practices.

Don't overlook the advantages of titanium for your jobs. You can get the sizes, grades and shapes of REM-CRU titanium you need *quickly* . . . for REM-CRU's expanded facilities make ample quantities available. And if you'd like, a REM-CRU engineer will be glad to help you make the best use of this versatile new metal.

To keep abreast of the latest developments on this vital metal, write to Dept. M12 for the Rem-Cru Review — a free periodical presenting the latest technical data on titanium alloys.

REM-CRU TITANIUM

REM-CRU TITANIUM, INC., MIDLAND, PENNSYLVANIA

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HEAT RESISTANT FINISH

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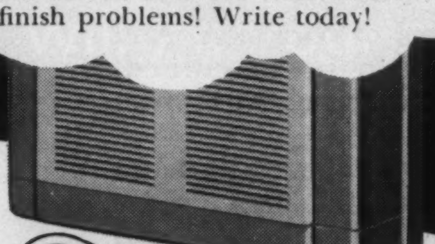
The upper grille of this handsome TEMCO Gas Wall Heater is finished with 7x7070 Brown SICON Silicone-Base Heat Resistant Finish. The number of louvers on this upper grille presented a chippage problem with vitreous enamel which prompted Temco to turn to SICON. Normal operating temperatures run about 350° F. but the temperature encountered on blocked flue conditions require a heat resistant finish to withstand 500° F...SICON 7x7070 Brown, on 25,000 or more Temco installations, has successfully met field performance requirements without loss of color, gloss or adhesion. Investigate other case histories of SICON—the remarkable finish that has solved over 150 heat resistant finish problems! Write today!



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MATERIALS ENGINEERING NEWS

sparkle through the whole range of the color spectrum according to David P. Reynolds, vice president in charge of sales, Reynolds Metals Co.

"The trend to two-tone and three-color schemes," he said, "opens a glowing opportunity for the use of the many attractive new finishes developed in aluminum—natural aluminum in many different textures, color anodized, and 'bright' anodized aluminum." He cited as an example the 1956 Cadillac which is featuring a gold-anodized aluminum grille.

Reynolds also predicted a trend to aluminum car roofs pointing out that there have been several brushed aluminum roofs on special cars in the past two years. In addition to their appearance—the soft, rich look of sterling silver—the roofs are efficient solar reflectors, lowing the car's interior temperature in the summer.

Since 1950, applications of aluminum in automobiles have grown from 5 to 35 items increasing the quantity of aluminum used in these applications $4\frac{1}{2}$ times. "The position of aluminum in the automotive industry," Reynolds concluded, "is brighter now than any prediction of five years ago."

Investment Casting in Vacuum

In the continuing search for tougher, stronger, more heat, resistant metal alloys, vacuum processing has played a growing role. High vacuum melting has produced alloys impossible to make by any other method, and has improved properties of standard alloys. Vacuum heat treating, too, has found uses in improving oxygen sensitive materials such as titanium and zirconium.

Investment casting

The latest application of vacuum metallurgy in the 10 micron range is for investment casting. What is claimed to be the first vacuum melting furnace designed specifically for the investment casting process has been put into operation on an experimental and pilot operation basis in the Dover, N. J., plant of Austenal Laboratories Microcast Div.

Introduction of vacuum casting to the investment process is expected to extend considerably the versatility of the process, permitting the use of a much wider variety of alloys, minimizing undesirable inclusions, and insuring greater strength and ductility of alloys now being used.

Melting metals in a vacuum performs two major functions: it eliminates gasses such as hydrogen and oxygen, which might cause variation in properties or result in actual voids in the metal; and it removes harmful oxides and slag compounds. The sensitivity to hydrogen embrittlement, oxidation, and slag formation are the chief limiting factors for many high performance alloys that might otherwise be useful as investment cast materials.

Precision parts

Investment casting in vacuum or at atmospheric pressure provides an excellent means to produce small precision parts in a wide range of alloys, ranging from the high strength superalloys, through the stainless steels, to carbon and low alloy steels. The process produces castings very close to finished tolerances, thus minimizing machining time and, scrap loss, which is not an inconsiderable factor when high priced or strategic materials are involved.

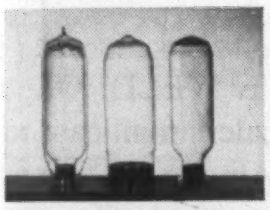
CORNING GLASS
BULLETIN FOR PRODUCT DESIGNERS

CORNING GLASS WORKS, 12-12 Crystal Street, Corning, New York
Please send me the following material:
☐ Booklet: "Glass and You."
☐ Bulletin B-83: "Properties of Selected Commercial Glassware."
☐ Bulletin IZ-1: "Glass . . . its increasing importance in product design."
Name____________________
Title____________________
Company____________________
Address____________________
City____________________ Zone__________ State__________

Something for nothing

In 1643 Evangelista Torricelli started studying causes and effects of vacuum. Two hundred years later, Sir James Dewar applied the principle of *insulation by nothing* to the vacuum jacketed vessel for storing liquid gases.

Up-dating on the vacuum vessel brings us to the ubiquitous bottles—useful companion of factory and office workers, picnickers, campers and school children. We play an inside role in this hot-cold game by making the inner-and-outer glass liners which are so important to the function of a vacuum bottle. Why glass? It's easy to clean, doesn't change taste of liquids and may be readily formed into shapes that hold a vacuum.



Component parts by Corning help keep vacuum bottlemakers happy and busy. From right to left—inner blank, outer blank and first assembly of glass liners for vacuum bottles.

Firms like Aladdin Industries, and Landers, Frary, & Clark buy these liners in great quantities. Then, with considerable ingenuity, and with the aid of automatic machinery, they seal the matched glass units, silver the outside of the inner and inside of the outer lining for more effective insulation, evacuate air between the walls, and tip to seal the vacuum permanently.

After 24 hours of testing, liners that make the grade are jacketed in attractive metal and/or plastic castings. Then, thousands of happy customers who want to keep food and drink both tasty, and at the right temperature, buy bottles in a wide variety of sizes, shapes, and styles.

Moral? If you want something for nothing—a vacuum that is—glass can be handy and profitable.

A more detailed story of Corning glass at work in both products and processes is unfolded in "Glass and You." A free copy is yours by request.

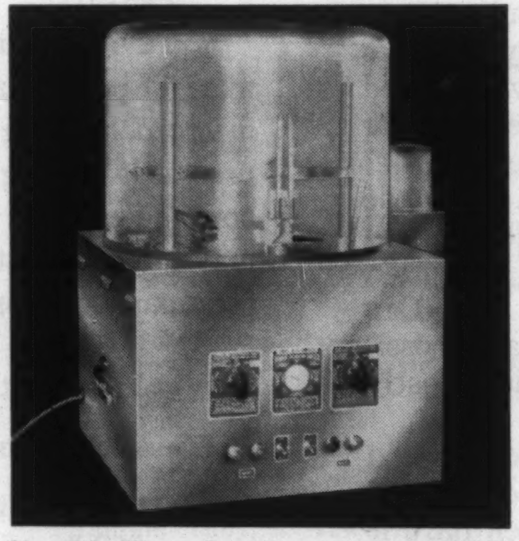
Also for your perusal Bulletin B-83, "Properties of Selected Commercial Glassware." It's a handy reference volume that will give you considerable insight into the amazing properties that can be custom-built into glass.

Handling humidity—with a moral for the cost-conscious designer

When it comes to handling and humoring humidity to fit experimental conditions, today's researchers demand precise control.

Toward this end, the Blue M Electric Company, of Blue Island, Illinois, has developed a relative humidity chamber that automatically controls humidity from 20% to near saturation, at any point, depending upon dry bulb temperature.

What interests us (aside from our curiosity about the precise handling of experimental conditions) is the use of a PYREX brand jar as the chamber. No small vessel this, it measures 16 inches in diameter, 12 inches in height.



Blue M's "Vapor-Temp" uses a large PYREX jar as a humidity chamber. Result—production costs and resultant prices go down.

Why a PYREX jar for this somewhat off-beat application?

The obvious answer lies in the full visibility the glass gives the lab technician who wants to observe test specimens from all angles. BUT . . . what *isn't* so obvious (except to Blue M) is the fact that, by using the PYREX jar they eliminate the expense of fabricating costly double wall alloy cabinets.

Blue M gets the jars in the quantities they need when they want them, and at a price that enables them to sell their product, "Vapor-Temp," at a figure in reach of more customers.

In turning to Corning for mass-produced glass components, you get utility *plus* economy—and Corning's capacity to cope with *both* materials and production problems.

Other examples of dollars-and-cents uses of glass components are spelled out in Bulletin IZ-1, "Glass . . . its increasing importance in product design."

How to engineer a continuing status quo

Status quo is the old Roman way of saying "the state existing."

Closely akin, and often of utmost importance to designers and engineers, is dimensional stability — a *continuing* status quo.

Dimensional stability, plus nonabrasive quality makes this glass ring a vital component in Sprague's planetary-valve gas meter.

Which leads us to the problem we ran into when the Sprague Meter people in Bridgeport were putting together their unique planetary-valve gas meter.

The valve ring was the stumper. It had to move continuously in a circular motion, sliding over a soft metal port in order to permit the measured flow of gas through successive orifices.

To be effective, the ring had to keep its shape, have an exceptionally flat finish, and neither wear (nor be worn down by) the metal part it moved against.

It may come as a surprise to discover that glass was selected as the material for the ring.

As mass-produced by Corning, this glass valve is precision flat finished by Sprague so smooth that it's nonabrasive to the metal it rubs against; it's hard enough not to be worn down, changing shape not a bit in operation.

Hundreds of material matters (other than Sprague meter valves) have found their successful solution in glass. Perhaps you can get your answer with it. Jot your problem down and send it along. We'll peer into our vault full of 50,000-odd glass formulas to see if we already have a glass to do your job. If not, we may be able to find just the right ingredients. We'd like to hear from you.

CORNING GLASS WORKS
CORNING, N. Y.
Corning means research in Glass

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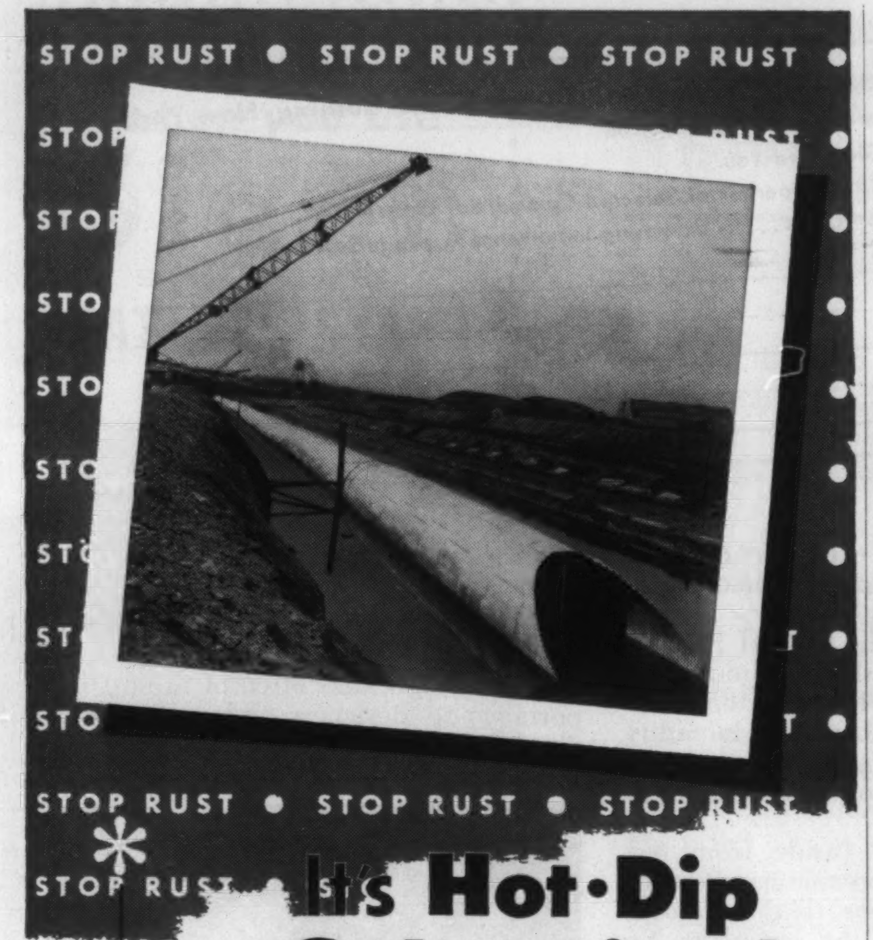
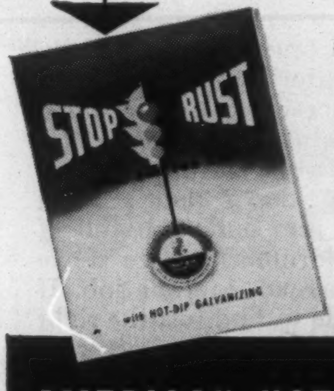

STOP RUST • STOP RUST • STOP RUST •
STOP RUST • STOP RUST • STOP RUST •

It's Hot-Dip Galvanized

TWO JOBS IN ONE. The culvert you see pictured here is actually two lines in one—one-half of the culvert is used for drainage . . . the other half for creek diversion. The culvert is 144″ in diameter and 1530′ long. It is made of 8 gauge steel, and completely Hot-Dip Galvanized. Once it is buried over it is there to stay. Hot-Dip Galvanizing will prevent any possibility of rust, thus saving costly maintenance.

Whether it's a large culvert, a chain link fence, or a fence post, remember, if it's iron or steel, have it Hot-Dip Galvanized. For the best in galvanizing, send your products to a member of the American Hot Dip Galvanizers Association . . . he has the know-how to give you a top quality job.



Send today for our new booklet "Stop Rust." It gives you the full story on the process, plus a comprehensive coating comparison chart. "Must It Rust" 16 mm film available for showing.

AMERICAN HOT-DIP GALVANIZERS ASSOCIATION
1506 FIRST NATIONAL BANK BLDG., PITTSBURGH 22, PA.

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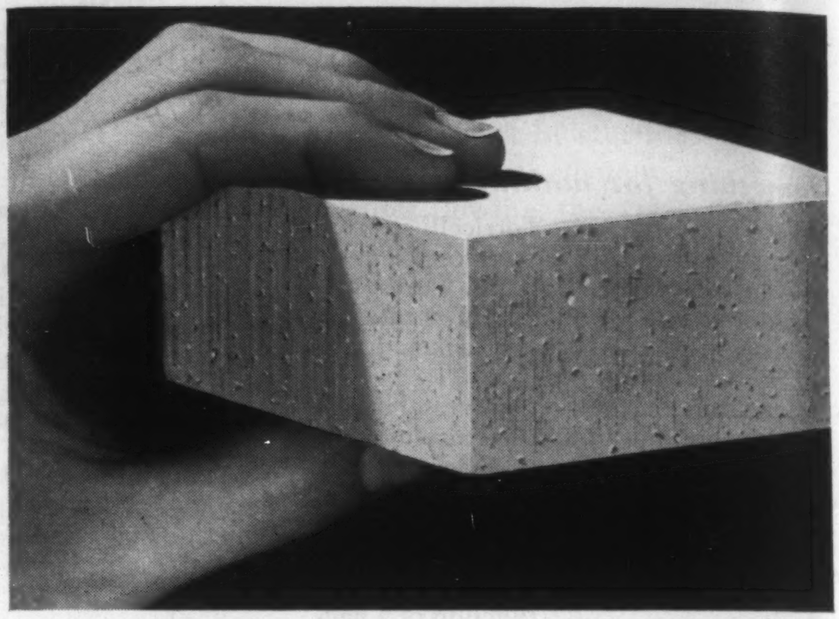
Can you use Weldrok®



The material you see here is WELDROK, a mineral panel made of inorganic calcium silicate reinforced by long asbestos fibers. Among its present uses, it is serving successfully as a sound buffer, as a core material, as an insulator, etc., etc. Its properties may indicate that WELDROK is just what you need for a particular product or new product development:

- Incombustible—Underwriters' Laboratory rating.
- Dimensionally stable.
- Strong. Minimum compressive strength: 550 lb. psi.
- Good heat insulator. Highly fire resistant even at high temperatures.
- Easily machined.
- Insoluble in water.
- Substantially neutral.
- Density: 22-23 lb. pr. cu. ft. (Density can be adjusted to customer's specifications.)
- 1¾″ thick x 19″ x 36″ (dressed size: approx. 18″ x 36″ x 1¾″).

We will be glad to supply a working sample of WELDROK. Just request it on your business letterhead.

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TWO NEW SILICONE RUBBER SHEET STOCKS

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For the first time silicone rubber sheet stocks are available in economical continuous-roll lengths

Du Pont offers these high-grade, general-purpose sheet stocks in two hardnesses—50 and 70 durometer—and three thicknesses—1-32″, 1-16″ and 1-8″.

Silicone rubber sheets are designed to fill the urgent need for gasket materials in high- and low-temperature applications. Flexible and strong, these sheets are resistant to temperature extremes, oil and abrasion . . . exhibit excellent anti-stick properties.

The unique properties of these new stocks may be just what you need to make a new design a success—or to improve an old one. The continuous-roll feature means more efficiency and economy, too. Why not have a Du Pont representative call on you to discuss possible applications of silicone rubber sheets? He'll be glad to be of service. Just clip and mail coupon for further information.

E. I. du Pont de Nemours & Co. (Inc.)
Fabrics Division, M-512, Fairfield, Conn.

I am interested in "Fairprene" Industrial Products.

( ) Have a representative call.
( ) Send further information on silicone sheet stocks.

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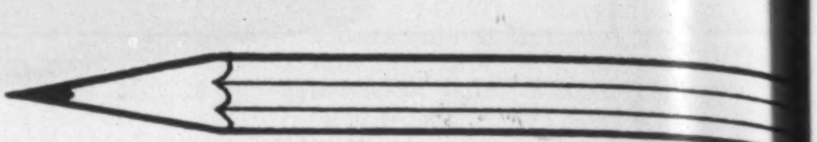

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the last word

Startling, but Logical

Recently we toured the new facilities of the Materials Manufacturing Department of Westinghouse at Blairsville, Pennsylvania. We were duly (not dully, we assure you) impressed by the variety and size of equipment being used to melt and roll special alloys as well as to develop various casting techniques. However, one small thing left a lasting impression. In a large section reserved for a new nuclear fuel element manufacturing area, there was, as yet, only one type of equipment. There, all by their lonesomes, were six gleaming automatic clothes washing machines (Westinghouse, naturally). Although the sight was surprising, the explanation was simple enough. Workers assigned to this radioactive area cannot send their clothing to commercial laundries; thus, they must be provided with facilities for doing their own washing.

Still a New Twist to Silicones

Never underestimate the power of a woman! We long have been conscious of the confusion in the lay mind between the term silicone and silicon. Therefore, we were not surprised the other day at a press luncheon to learn from a starry-eyed young correspondent from a woman's magazine, of the wonderful things being done with the new water repellent material—silicon. When asked if she were not referring to silicone, we were rather dumbfounded to learn that she did mean silicon. You see, bright-eyes explained, silicone is a generic name, but Silicon is the trade name for silicone materials produced by one of the chemical companies. Thus straightened out, we attacked our fruit cup with a new vigor.

A New Property

Perhaps the young lady could use some of a new property which we seem to have discovered. We can think of many uses for this new property, but the producers of vulcanized fibre were surprised, considerably, we might say, to learn that their products were so endowed. The property to which we refer was labelled "comprehensive strength" in a recent File Fact. We are not quite sure what the property is, but have a vague feeling that it is the opposite of elastic memory.

The Reader Writes

We, as magazine publishers, are inured to receiving correspondence in all shapes and forms. Nevertheless, we were amused at one letter received recently. We'll give the message first and then the explanation. The letter reads: "I am not writing this note where you think but am operating a stress machine. When I am home I never think about writing to you." The message was written on what looked to be brown paper toweling. But as the man said, he was not where we thought, so it must be the type of toweling used to remove excess oil from hands and equipment.

T. C. Du Mond

Editor

Another new development using

B. F. Goodrich Chemical *raw materials*

B. F. Goodrich Chemical Company does not manufacture this pipe. We supply only the Geon resin.

CHECK THESE 4-WAY SAVINGS WITH RIGID VINYL PIPE

Installation time cut • Heavy machinery eliminated • Two man crew does the job • No corrosion, longer life.

Here's a hot case history of how costs were cut four separate ways by specifying plastic pipe made from Geon high impact rigid vinyl resin. The installation collects crude oil in a water flood system near Tulsa, Oklahoma.

The plastic pipe replaces 2 miles of steel pipe that failed due to salt and sulphur corrosion. A two man crew laid 640 feet of 3 inch rigid vinyl pipe made from Geon resin in an hour. No heavy machinery was used; the pipe is so light a length can be handled by one man.

Biggest saving comes from the long life of rigid vinyl pipe made from Geon resin. It withstands rough handling, won't corrode, has better chemical resistance, and costs less than many other pipe materials.

Rigid plastic pipe is but one of many products made from Geon polyvinyl materials that show similar economies in both installation and upkeep. Sheets, valves and other products used in the petroleum and chemical industries demonstrate daily the versatile qualities of Geon polyvinyl materials. For information on Geon materials, please write Dept. BP-6, B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

A TRADE MARK OF B. F. GOODRICH CHEMICAL COMPANY
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Polyvinyl Materials
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GEON RESINS • GOOD-RITE PLASTICIZERS . . . the ideal team to make products easier, better and more saleable.

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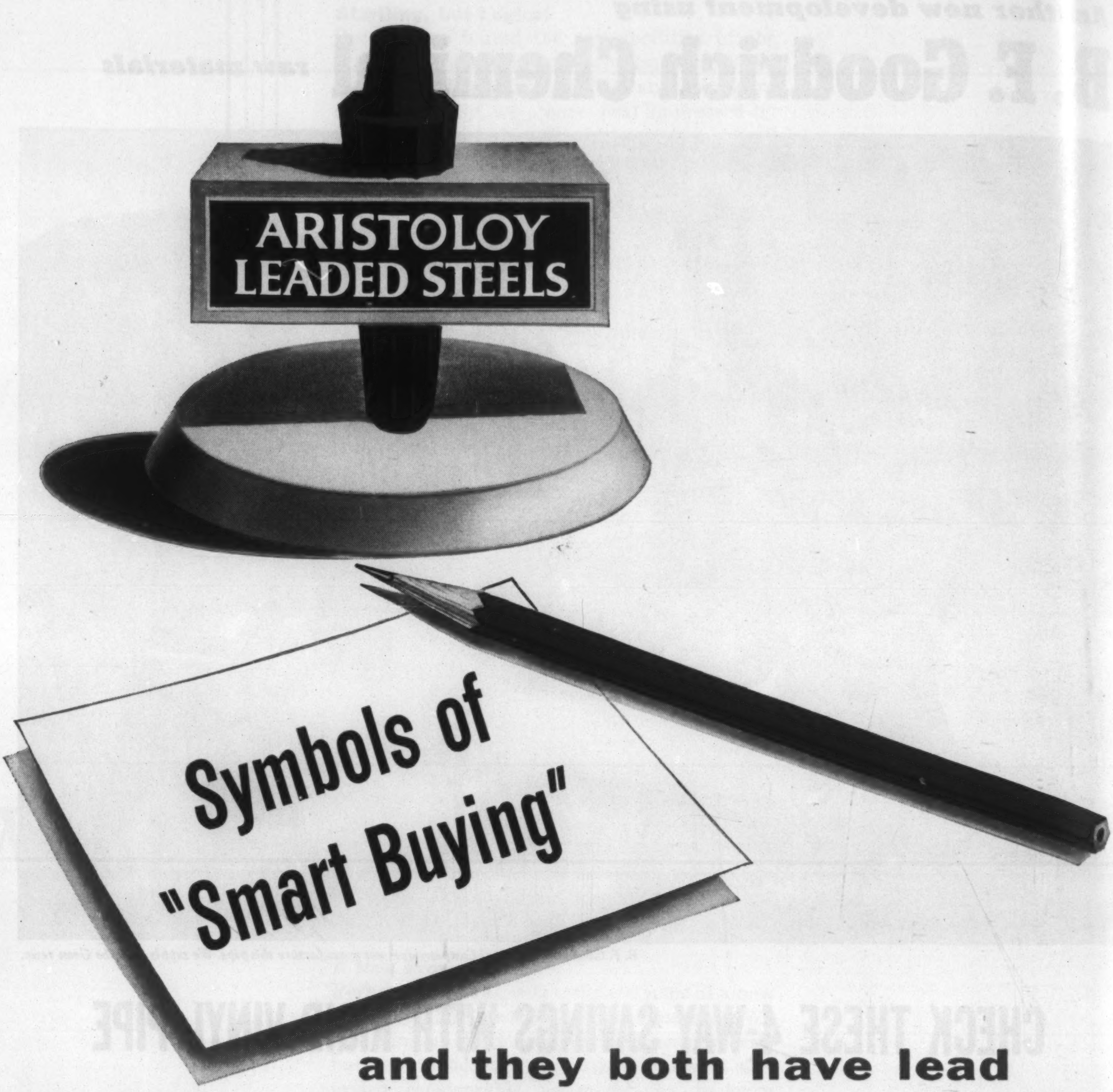
For more information, turn to Reader Service Card, Circle No. 407



and they both have lead

Today's Purchasing Agent is recognized as part of the executive management team. Why? Because the modern PA, using value analysis, is looking beyond initial cost to specify products that can be purchased to be produced at a profit.

Parts machined from Ledloy* give production line savings.

Freer machining, faster feeds and speeds and longer tool life add value through each manufacturing step.

Because Ledloy cuts clean for finer finish, its use sometimes eliminates final machining.

The end result—a total saving accumulated step by step from rough stock to finished product that makes Ledloy a "smart buy."

*Inland Ledloy License

COPPERWELD STEEL COMPANY / STEEL DIVISION / WARREN, OHIO

For more information, turn to Reader Service Card, Circle No. 361

no undercut

in new type welded stainless steel pipe

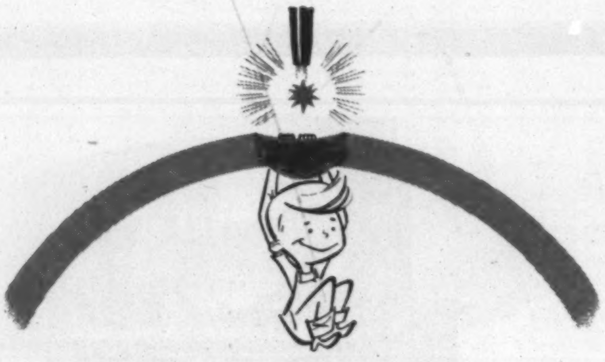
Now, TRENTWELD is better than ever! Thanks to Trent's new patented *Contour-Weld** process, you can now get stainless pipe or tubing that's really smooth inside . . . free from any undercut or projecting weld bead.

Check these Benefits

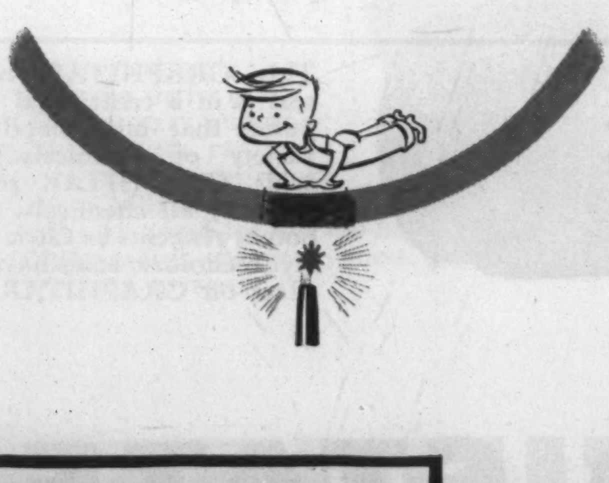
As before, this new-type TRENTWELD is made from uniformly rolled stainless strip. That's why you'll always get extremely high uniformity both of wall thickness and curvature. And Trent's new *Contour-Welding* brings that same uniformity to the weld zone itself. This means a stronger pipe or tube with smoother flanged or flared ends . . . no cavitation corrosion or erosion . . . better performance in every category than with any other, welded or not.

Try new Trent *Contour-Welded* pipe or tubing for yourself. It's a natural for pressure lines . . . lines carrying corrosive chemicals . . . high-velocity systems. And remember, it's made by Trent—tube-mill specialists.

Why Trent's Exclusive Contour-Weld Process Means Smoother Welds . . .



With conventional welding, gravity means beads . . . or undercut, particularly in heavy sections. Gravity pulls some of the molten metal down into the pipe to form a bead that is extremely difficult to remove by cold working. And cold working of the inside bead can lead to undercuts, focal points for erosive and corrosive attack. Cleaning becomes difficult.



With new Contour-Welding, *gravity means smoothness.* Trent's new *Contour-Welding* puts gravity to work. The pipe is inverted, and welded at the bottom. Gravity still pulls the molten metal down — but that simply makes the weld-bead contour correspond to the contour of the pipe itself. That's why there's no tell-tale bulge of weld metal on the critical inside surface. And even on the outside, the weld bead more closely approaches that of the parent metal than other welded pipe.

Contour-Weld is the trade mark of the Trent Tube Co. for its process of welding pipe and tubing which is protected under U.S. Patent 2,716,692.

TRENTWELD STAINLESS STEEL TUBING

TRENT TUBE COMPANY, GENERAL SALES OFFICES, EAST TROY, WISCONSIN (Subsidiary of CRUCIBLE STEEL COMPANY OF AMERICA)

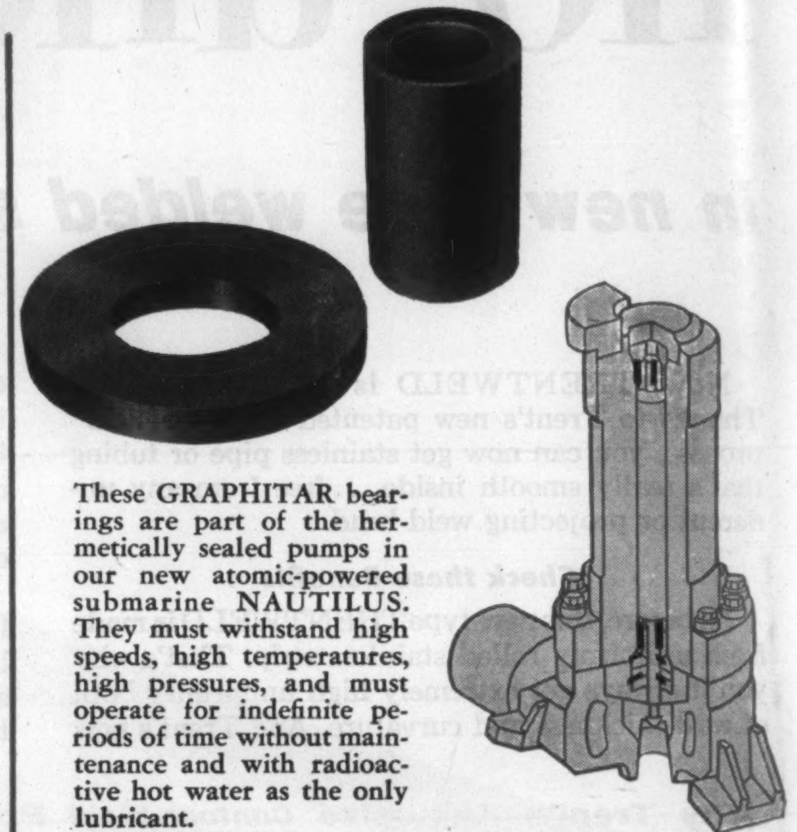
For more information, turn to Reader Service Card, Circle No. 353

GRAPHITAR® . . . the versatile

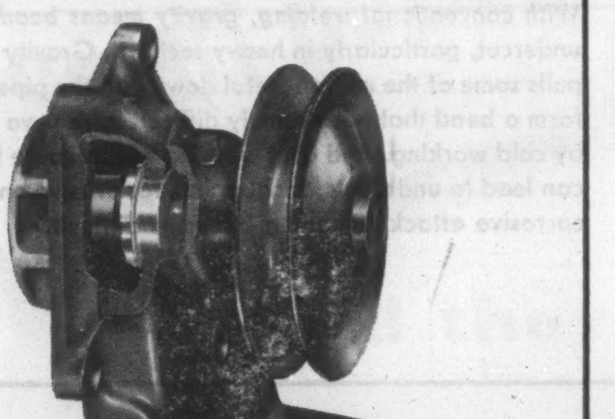
(CARBON-GRAPHITE)

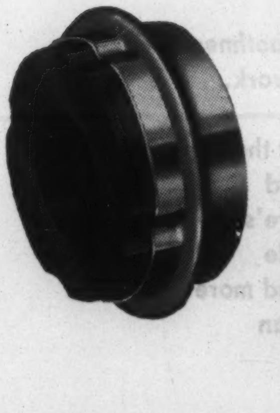
insuring the performance

There are literally hundreds of difficult applications where the only completely successful material is GRAPHITAR. It can be used where water and steam are present . . . in fact, where *only* water and steam are present . . . because it does not need oil lubrication. It can be used where the temperatures are those of a toaster or the pressures those of a pump. GRAPHITAR is a versatile engineering material produced from carbon-graphite powders, compacted under terrific pressure and fused at heats near 4500° F. It can be formed in relatively complicated shapes and ground to tolerances as close as .0005″ for seals, bearings, vanes, piston liners and many other parts. GRAPHITAR is lightweight, strong and durable, chemically inert, and virtually unaffected by high speeds, high pressures, or temperature extremes. Write today for our illustrated 64-page GRAPHITAR catalog.

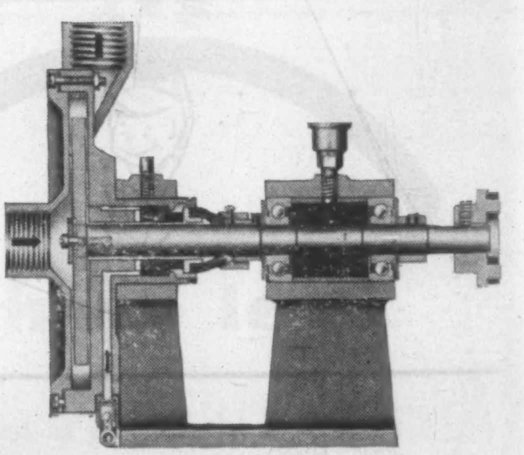


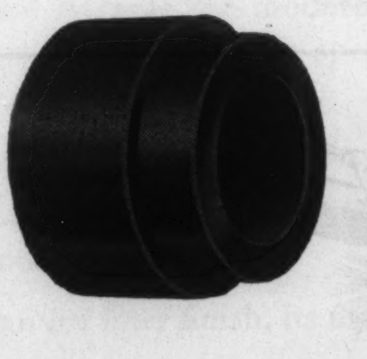
These GRAPHITAR bearings are part of the hermetically sealed pumps in our new atomic-powered submarine NAUTILUS. They must withstand high speeds, high temperatures, high pressures, and must operate for indefinite periods of time without maintenance and with radioactive hot water as the only lubricant.





GRAPHITAR is a standard part of this latest type automotive water pump seal. This seal will not leak hot water, cold water, or any type of antifreeze; the wear resistance and chemical resistance of GRAPHITAR insure a seal that will last for the life of the car.



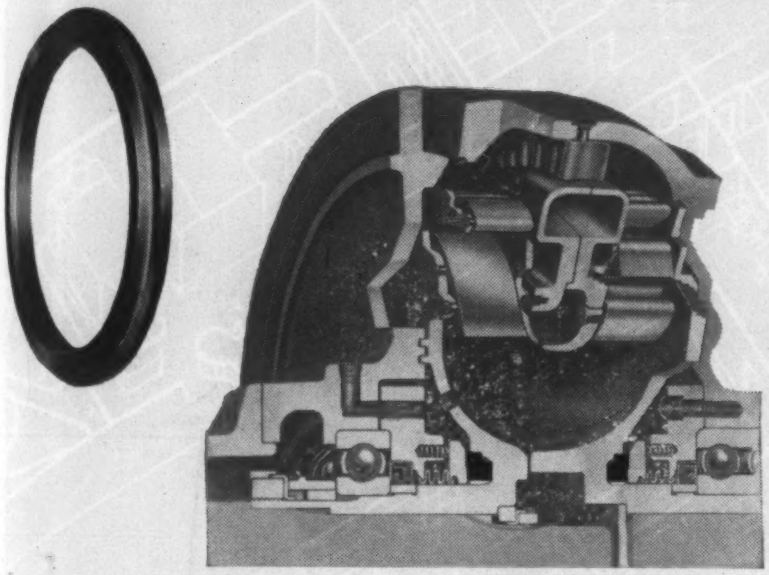


This GRAPHITAR block seal is in a centrifugal type pump that must handle a variety of chemicals and acids. GRAPHITAR resists virtually all chemicals; such potent reagents as Citric and Hydrocholoric acids have no effect on GRAPHITAR.

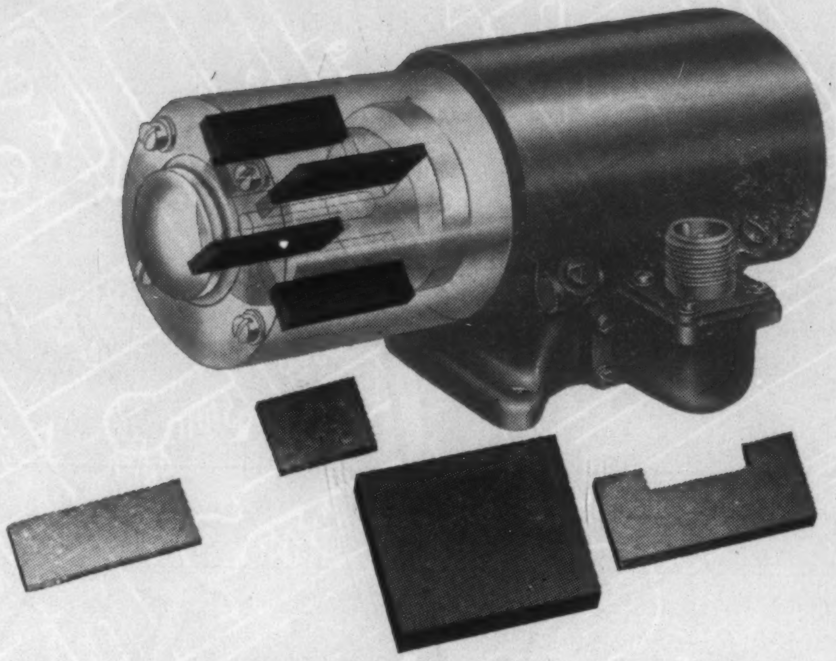
OUR 101ST YEAR

THE UNITED STATES

material that is of hundreds of products

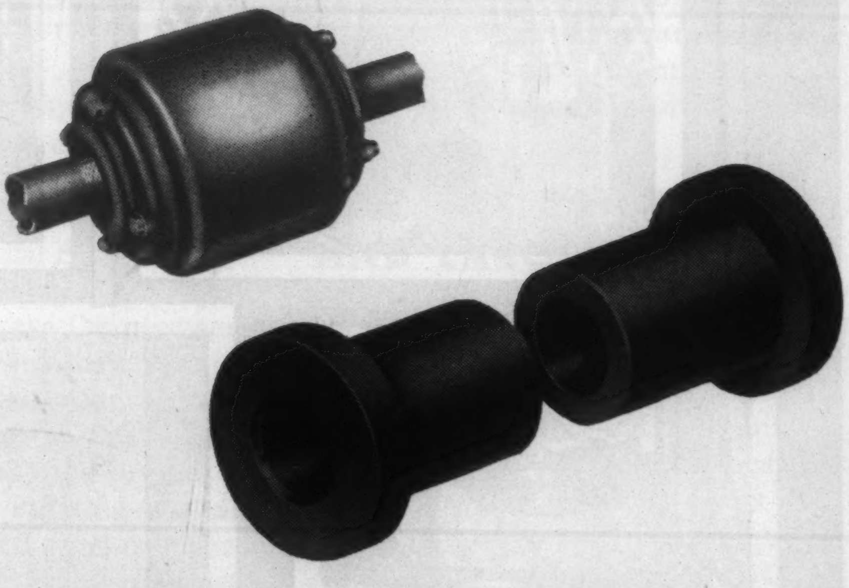


Operating at temperatures up to 350° and 400° F., under pressures of 100 psi and rotating at 1000 feet per minute, GRAPHITAR seals in this industrial torque converter hold a static head and will not gall or leak hot oil. The lapped flat surfaces do not warp or distort.



Rotary pumps, compressors, air motors, vacuum pumps and similar machines equipped with GRAPHITAR vanes function efficiently, give long service, and require little or no maintenance. 25,000,000 of these vanes are now operating in automobiles, in aircraft, in farm equipment, and in household appliances.

These mechanical seals rotate with the shafts of such units as rotary pumps, autoclaves, blowers, etc., to provide a pressure-tight rotary seal. The GRAPHITAR gland insert is ideally suited for this use because it is self-lubricating, chemically inert, and highly resistant to wear.

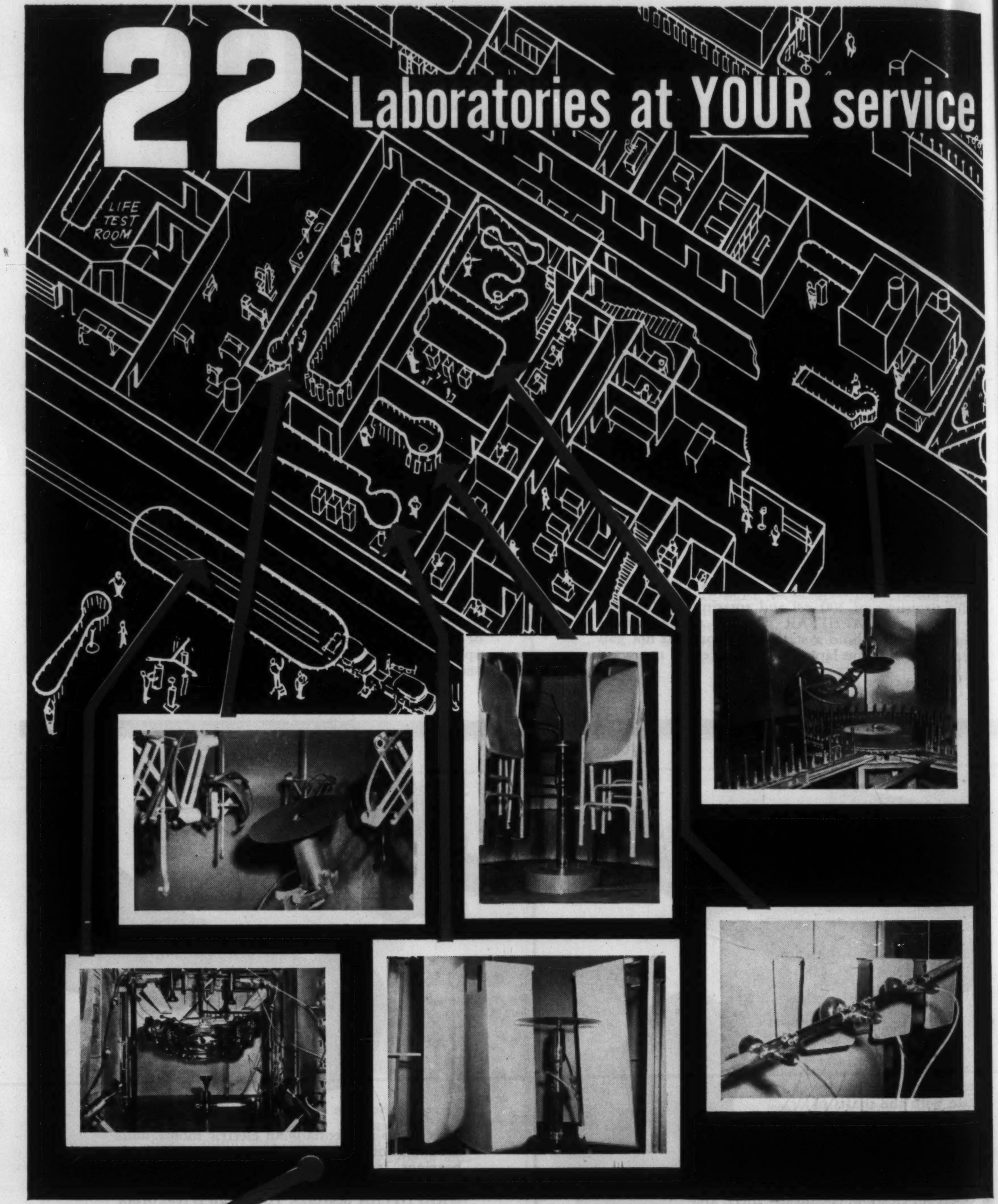


This pump is essentially an electric motor built around a rotor supported by two GRAPHITAR bearings. It can pump almost any liquid, and the liquid itself is the only lubricant for the GRAPHITAR bearings. The pump is leakproof and needs no oiling.

GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW, MICHIGAN

For more information, turn to Reader Service Card, Circle No. 498


22 Laboratories at YOUR service
LIFE TEST ROOM

YOUR JOB, LIKE THESE SHOWN ABOVE, WILL BE TEST PROVEN

under simulated production conditions to determine cost-saving benefits and other advantages. Ransburg also maintains other test facilities in Los Angeles, London, England; Bad Hersfeld, Germany; Paris, France and Sydney, Australia.

to prove the painting of YOUR products with

RANSBURG

Electrostatic Painting Processes

Let us make laboratory tests and prove the advantages and cost-saving benefits of painting YOUR products AUTOMATICALLY with one of the Ransburg Electro-Spray Processes.

GET THE FACTS . . . IT COSTS YOU NOTHING!

STEP BY STEP—HERE'S WHAT YOU GET . . .

- Survey of your plant by Ransburg's experienced field engineers, including savings estimate.
- Lab painting demonstration of your products, using equipment closely simulating your own production conditions.
- Accurate measurements of paint film thickness.
- Engineering report of detailed tests to determine paint and labor savings.
- Coated samples of your job, lab production photos, and even movies if desired.
- Detailed drawings of equipment and workholder.

All of the above without obligation to you. And, before equipment is installed you receive detailed, pre-installation instructions. Too, a well-qualified, experienced engineer supervises installation and trains your operator on the job. Ransburg offers continuing laboratory and field service to help you with any of your finishing operations.

Ransburg

ELECTRO-COATING CORP.

Indianapolis 7, Indiana

● **First,** Ransburg sales engineers will make a survey in your plant to check the possibilities of using Electrostatic Spray Painting on your products. Next, you will send samples of your unpainted products—with paint—to the Ransburg laboratories in Indianapolis.

Here, the technical staff takes over. The Ransburg Engineering staff—which includes PH.D's and Masters in Physics, Science, Electrical, Mechanical and Chemical Engineering—makes a complete study of your job. Not only do they have the necessary academic training, but they have the "know how" gained from years of actual experience in the field. Ransburg, you know, was the pioneer in Electrostatic Spray Painting 15 years ago. Engineers and well-qualified technicians have at their disposal every facility for conducting complete tests, simulating your own production conditions. They'll decide which type conveyor is best suited for your job. (There's a conveyorized lab set-up—22 in all—to handle products ranging in size from automobile bodies and chassis to small components, such as window hardware.) They'll design workholders, if necessary, and determine exactly how your job can be run to your best advantage. Details, such as fixture spacing, will be worked out too.

After preliminary studies and tests, you are invited to Indianapolis to see your job run in the lab. If you wish, photos and even movies of your test run can be made and furnished for your own production people to study. You see first-hand what Ransburg Electrostatic Spray Painting can do for you in your own plant.

YOU GET PAINT AND LABOR SAVINGS

Paint usage is accurately measured during the demonstration. The Ransburg No. 2 Process will provide savings up to five times the paint mileage of hand spray. And, one unit can do the work of many hand sprayers. You will see the improved, uniform quality of the work . . . you'll know what kind of increased production to expect, and you can recognize labor savings. ALL OF THIS WITHOUT OBLIGATION.

Ransburg service doesn't end there. After the equipment is installed in your plant—with our supervisory help—we will train your operator and continue to work with your finishing department. Our technically-trained field service engineers are always available to assist with any of your finishing problems.

Briefly, that's our story. Now it's your move. Call or write. Dept. M.

For more information, turn to Reader Service Card, Circle No. 408

another revolutionary development by La Salle

THE **NEW**

...gives **HIGH STRENGTH..**

"FATIGUE-PROOF" steel bars offer high strength in-the-bar .. without the expense and trouble of heat treating. Tensile strength is in the 140,000 to 150,000 p. s. i. range .. hardness which is related to this strength level is approximately 30 Rockwell "C."

"FATIGUE-PROOF" has uniform strength across the bar .. no soft centers. (This uniformity is maintained from bar to bar .. lot to lot.) This remarkable uniformity of strength makes "FATIGUE-PROOF" ideal for applications in the 140,000 to 150,000 p. s. i. range that formerly required heat treated carbon and alloy steels, either hot rolled or cold drawn.

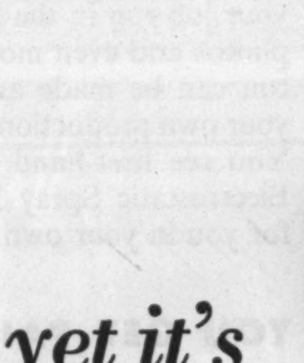
With "FATIGUE-PROOF" you'll get the advantages of heat treating .. none of the disadvantages. In short, you'll get a better part at lower cost.

...yet it's **EASY TO MACHINE**

"FATIGUE-PROOF" *is* a free-machining steel bar .. without question. It machines at least 25% faster than annealed alloys .. 50% to 100% faster than heat treated alloys.

"FATIGUE-PROOF's" excellent machinability permits faster speeds, heavier feeds, better tool life .. your production rates will increase .. you'll get more parts per hour.

Distortion from machining is held to a minimum .. there is no reduction of tool life due to the higher speeds and heavier feeds .. and surface finish is greatly improved.



La Salle **STEEL CO.**

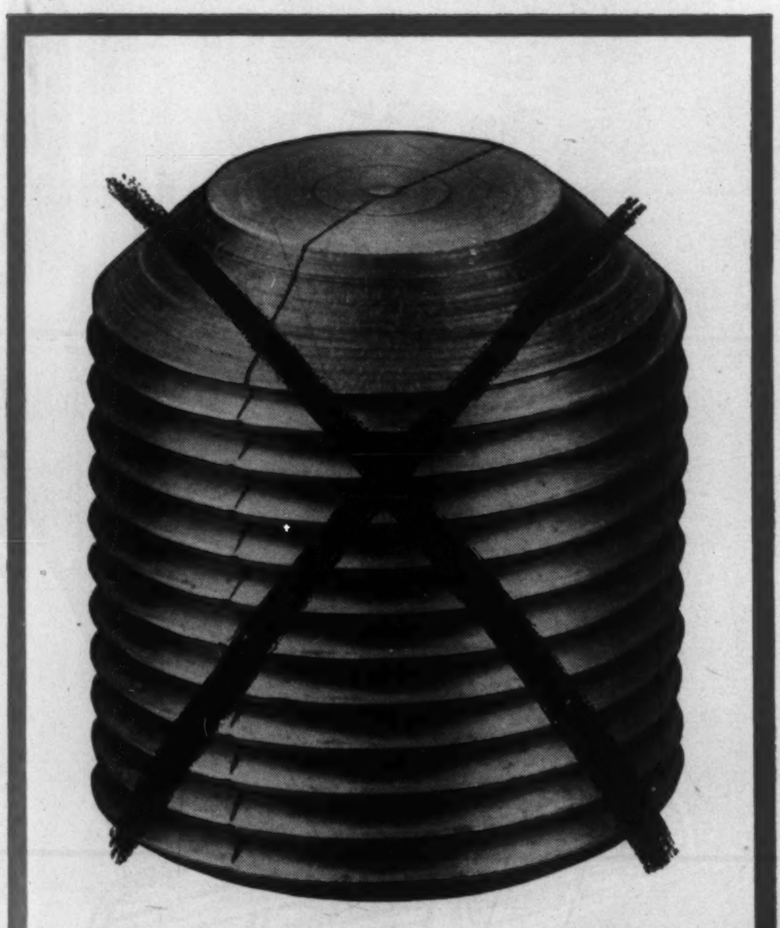
1418 150th Street, Hammond, Indiana

Manufacturers of America's Most Complete Line
of *Quality* Cold-Finished Steel Bars

For more information, turn to Reader Service Card, Circle No. 408

fatigue-proof STEEL BAR

WITHOUT HEAT TREATING

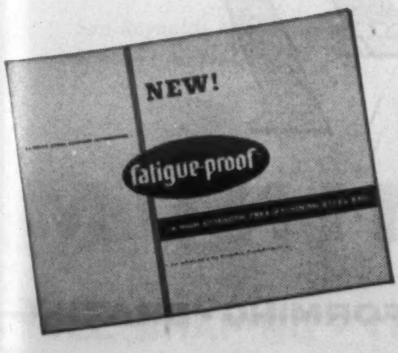


- *no quench cracks*
- *no distortion from heat treating*

With heat treating eliminated, the problems that accompany heat treating are avoided. Quench cracks become a thing of the past. Distortion and warpage from heat treating don't occur . . consequently time consuming and costly straightening and cleaning operations are not necessary.

You eliminate not only the cost of heat treating but also its disadvantages.

If you have parts where strength is a requirement . . you can save money and get away from problems by using "FATIGUE-PROOF." Our Sales Engineers will be happy to show you how this can be accomplished and provide samples for test purposes.



JUST PUBLISHED! Ask for your copy of the new 20-page booklet which gives additional information on the remarkable new "FATIGUE-PROOF."

LA SALLE STEEL CO.
1418 150th Street
Hammond, Indiana

Please send me your "FATIGUE-PROOF" Bulletin.

Name____________________
Title ____________________
Company____________________
Address____________________
City________ **Zone**____ **State**________

For more information, turn to Reader Service Card, Circle No. 479

for finer "finished" aluminum products

FINISHES

Reynolds modern electrolytic finishing equipment is used extensively by many manufacturers for highest quality plain and color anodizing. Anodizing protects surfaces and color anodizing by Reynolds is currently adding tremendous sales appeal to many items such as refrigerator and range parts; automobile grilles and trim parts, etc. The latest gold, blue and copper colors are currently being produced by Reynolds.

REYNOLDS ALUMINUM

BLANKING • EMBOSSING • STAMPING • DRAWING • RIVETING • FORMING • BRAZING

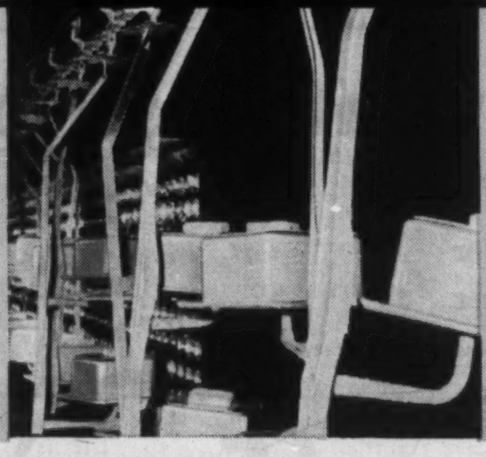
. . . greater design freedom, specify

from REYNOLDS

Mechanical • Chemical • Electrolytic • Paint Films

Buffing, here on deep well cookers, is one type of mechanical finish available from Reynolds. Scratch-brushing, satin finishing, highlighting, embossing and other finishes are also available.

Alodine system at Reynolds is adaptable to immersion, spray or brush type finishing. Etching, brightening and other chemical finish treatments are also available at Reynolds.



Reynolds can paint entire parts a solid color, mask and paint or do paint filling in combination with mechanical finishing to supply practically any desired texture or highlighting effect.

The aluminum products you are designing now can be finished to meet your requirements by Reynolds Aluminum Fabricating Service — and here's why:

Reynolds existing extensive finishing facilities are currently being augmented by today's latest automatic finishing equipment. This tremendous investment by Reynolds offers you finishing facilities unsurpassed anywhere. It assures you finer finishes on the aluminum products you design. Gives you new flexibility in your design thinking. And —these new expanded facilities are backed up by Reynolds years of technical experience with practically every finishing process and technique applicable to aluminum . . . and by Reynolds famous quality control from mine to finished product.

For the highest quality from start to "finish," let Reynolds fabricate and finish your aluminum parts.

For full details on the many types of mechanical, chemical, electrolytic and paint film finishes that Reynolds offers and on the many other services offered by Reynolds, call the Reynolds office listed under "Aluminum" in your classified telephone directory. Or write *Reynolds Aluminum Fabricating Service, 2060 So. Ninth St., Louisville 1, Ky.*

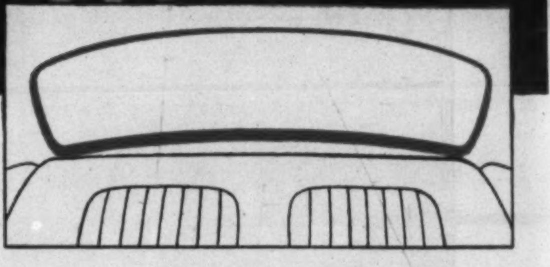
Write for your free copy of the 24-page "Catalog of Facilities." Get full details on the tremendous production facilities of Reynolds Aluminum Fabricating Service.

See Reynolds New Program "Frontier" Sundays on NBC-TV.

FABRICATING SERVICE

ROLL SHAPING • TUBE BENDING • WELDING • FINISHING • IMPACT EXTRUDING

For more information, turn to Reader Service Card, Circle No. 486



Dodge selects Enjay Butyl rubber for big rear-window weatherstrip

Super-durable Enjay Butyl fits perfectly Dodge's rigid specifications for its rear-window weatherstrip. Under the toughest conditions of weather and use, Enjay Butyl parts stay like new, help add style and color to new cars. In fact, some automobiles have more than 100 parts made of this fabulous rubber.

The many advantages of Enjay Butyl make it the almost perfect rubber for the automotive industry. Its price and ready availability are advantages, too. And it is now available in non-staining grades for *white* and *light-colored* parts. For full information and for skilled technical assistance in the uses of Enjay Butyl, contact the Enjay Company at either of the addresses below.

ENJAY
BUTYL

Enjay Butyl is the super-durable rubber with *outstanding* resistance to aging • abrasion • tear • chipping • cracking • ozone and corona • chemicals • gases • heat • cold • sunlight • moisture.

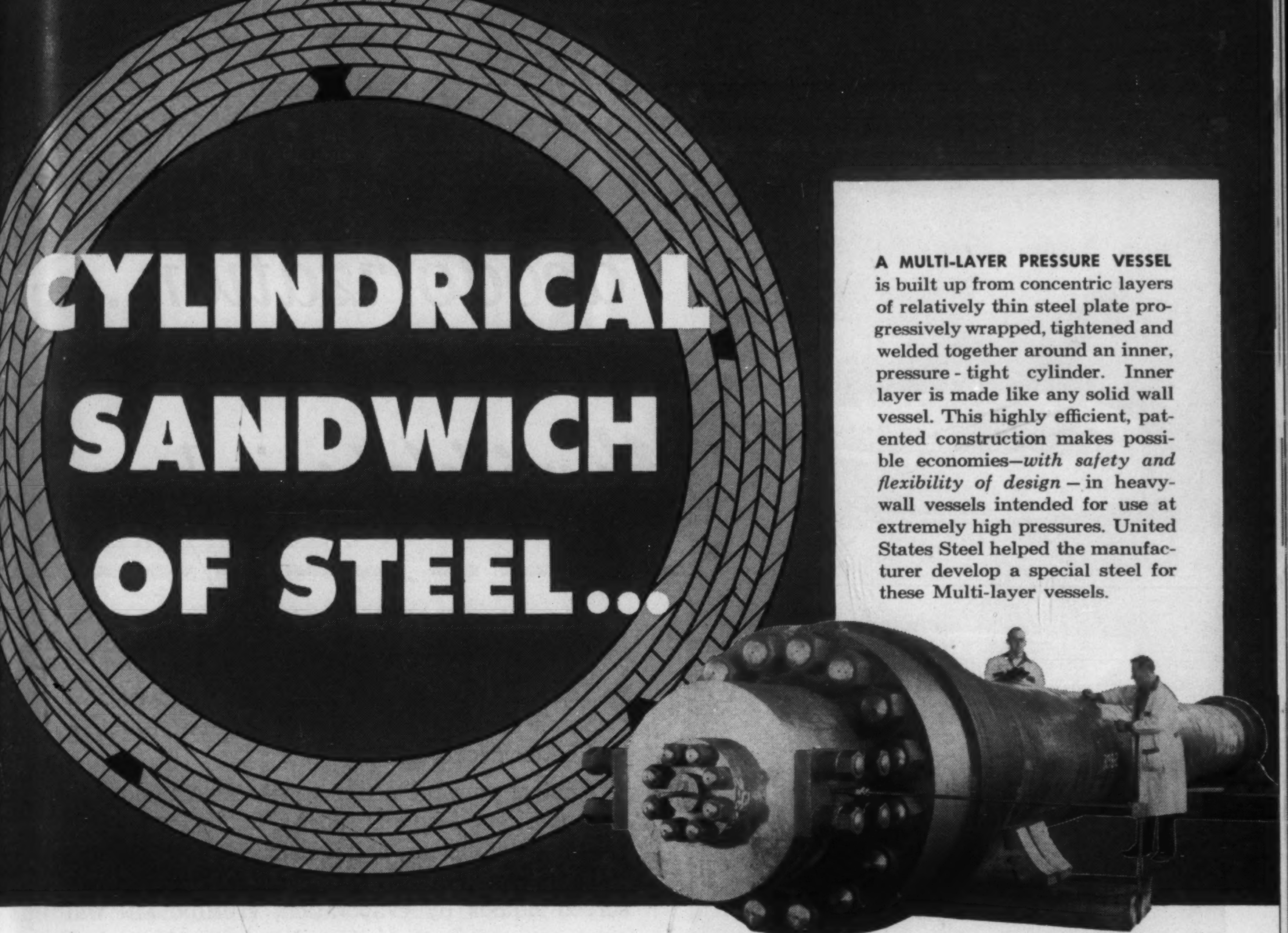
ENJAY COMPANY, INC., 15 West 51st Street, New York 19, N. Y.
District Office: 11 South Portage Path, Akron 3, Ohio.

35 SUCCESSFUL YEARS OF LEADERSHIP IN SERVING INDUSTRY

For more information, turn to Reader Service Card, Circle No. 302

For more information, Circle No. 358 ➤

CYLINDRICAL SANDWICH OF STEEL...



A MULTI-LAYER PRESSURE VESSEL is built up from concentric layers of relatively thin steel plate progressively wrapped, tightened and welded together around an inner, pressure-tight cylinder. Inner layer is made like any solid wall vessel. This highly efficient, patented construction makes possible economies—*with safety and flexibility of design*—in heavy-wall vessels intended for use at extremely high pressures. United States Steel helped the manufacturer develop a special steel for these Multi-layer vessels.

saves money on heavy-wall, high-pressure vessels

With its ingenious Multi-layer pressure vessels, A. O. Smith Corporation opens up almost unlimited possibilities to the design engineer for commercial-size vessels for unusually high pressures—from 7500 to 30,000 psi. Instead of using hard-to-fabricate, heavy-gauge plates, A. O. Smith builds up the thick walls of these vessels with multiple layers of thin steel. As a result, welding conditions are improved and stress relief is not needed. Consequently, Multi-layer fabrication of heavy wall cylinders is more economical.

USS METALLURGICAL SERVICE HELPED SOLVE THE PROBLEM

When A. O. Smith engineers first conceived Multi-layer construction, process pressures were within limitations of standard A.S.T.M. steel strengths. However, as pressure demands increased, A. O. Smith needed a new and very special steel. And that is where United States Steel came to their aid. We helped them develop a high-tensile, high-yield strength, low-alloy plate steel with a minimum ultimate strength of 105,000 psi., a minimum yield strength of 70,000 psi., and good weldability.

HELP FOR YOU

When you have any sort of steel problem, let USS metallurgists help you with it—whether you need a special steel or just want to be sure you have the *very best* of the standard AISI analyses for your job. Phone our nearest district sales office. Or write United States Steel, Room 5024, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

See The United States Steel Hour. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

UNITED STATES STEEL CORPORATION, PITTSBURGH • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
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UNITED STATES STEEL EXPORT COMPANY, NEW YORK

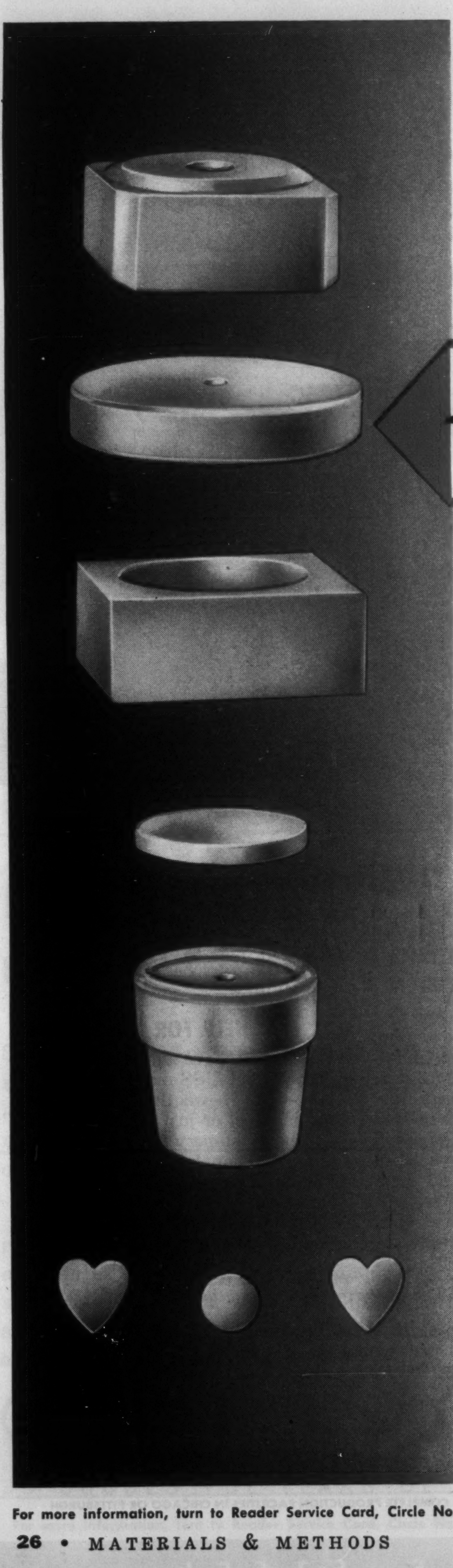
Carilloy USS Steels

ELECTRIC FURNACE OR OPEN HEARTH

COMPLETE PRODUCTION FACILITIES IN CHICAGO OR PITTSBURGH

5-2213

UNITED STATES STEEL



if it's deodorization . . .

Humidolain® *is basic!*

You'll like everything about HUMIDOLAIN . . . Star's *basic* ceramic for aromatic impregnation and better deodorization.

Whether your problem involves the manufacture of deodorizers, food and tobacco humidors, air conditioning equipment, humidifiers, or any other special application involving the gradual release of absorbed liquids by evaporation, HUMIDOLAIN will meet or exceed your strictest specifications. And for good reason!

HUMIDOLAIN is easy to handle . . . it's a highly porous but firm ceramic material. Once impregnated, solutions cannot be squeezed out.

HUMIDOLAIN is attractive in appearance . . . it's clean and white, instantly conveying the idea of sanitation.

HUMIDOLAIN retains its shape permanently... once molded, this Star ceramic never changes . . . only the aromatic evaporates.

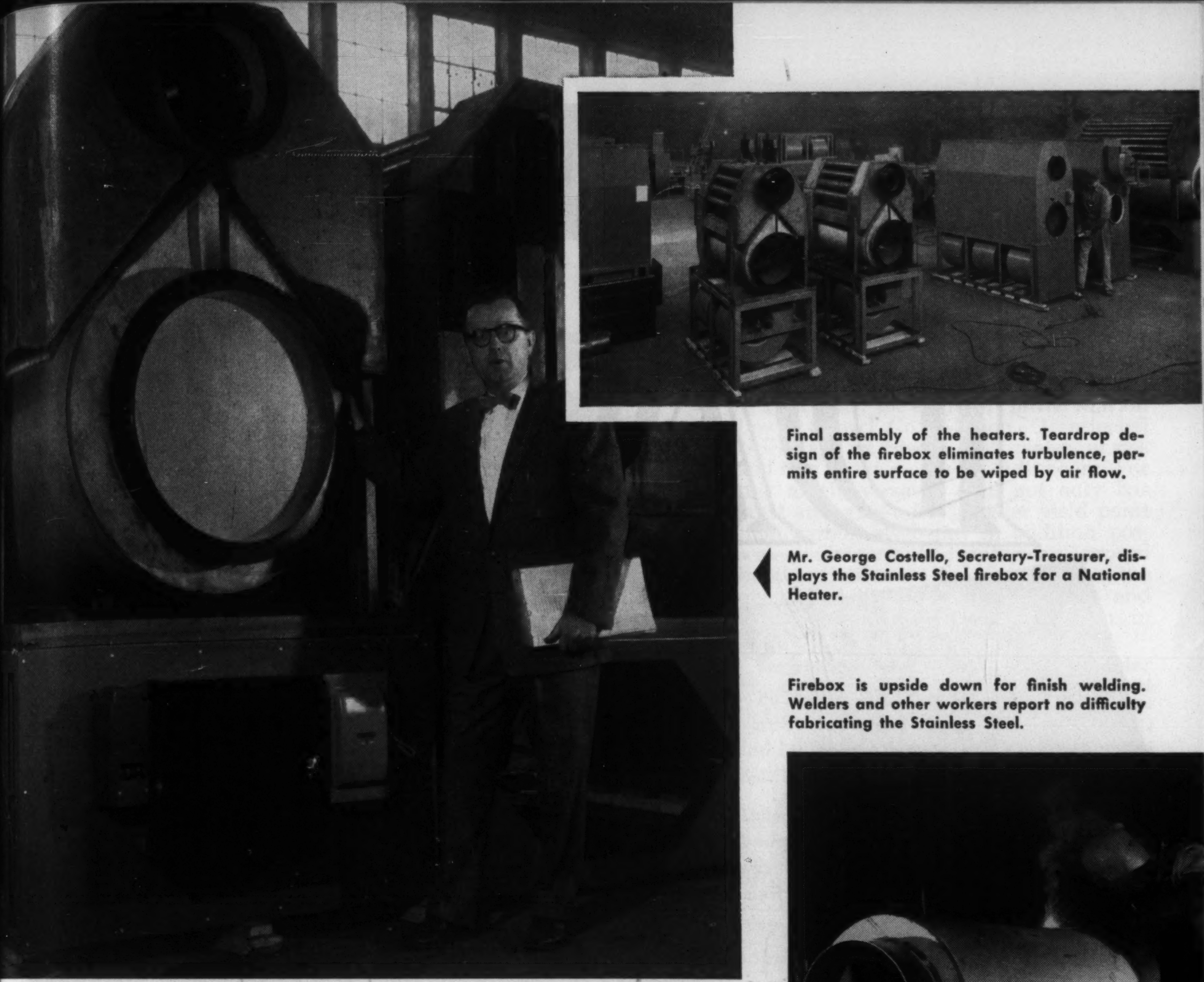
Why not get acquainted with HUMIDOLAIN *now*? We'll be happy to supply you with complete information about this basic material for better deodorization. And samples are available, too. The time to write is now.

STAR PORCELAIN COMPANY, 39 Muirhead Avenue,
Trenton 9, N.J.

STAR
porcelain company

For more information, turn to Reader Service Card, Circle No. 334

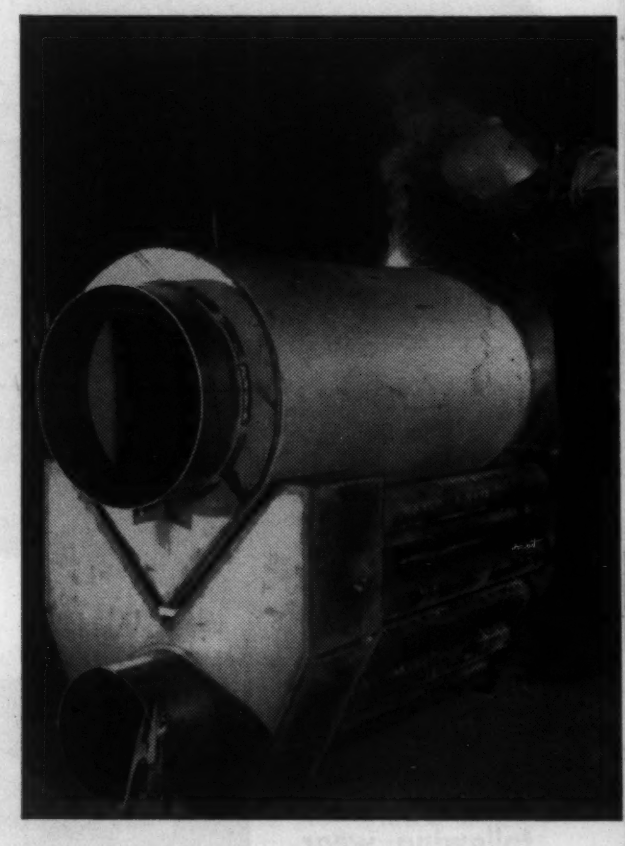
For more information, Circle No. 310 ➤



Final assembly of the heaters. Teardrop design of the firebox eliminates turbulence, permits entire surface to be wiped by air flow.

◀ Mr. George Costello, Secretary-Treasurer, displays the Stainless Steel firebox for a National Heater.

Firebox is upside down for finish welding. Welders and other workers report no difficulty fabricating the Stainless Steel.



1945: Heater size reduced 25% with Stainless Steel

TODAY: *Increased unit efficiency—increased heater sales*

National Heater Company, St. Paul, Minn., has been making quality industrial heaters for 20 years. In 1945, they looked for a way to reduce the *size* of the units without reducing efficiency.

Primarily, it was a problem of moving the steel firebox walls closer to the flame. But carbon steel would eventually oxidize and lose its shape when brought too close to the flame. So they tried Stainless Steel, and it worked.

The new firebox was made from 14-gauge Stainless Steel. It retained its shape, strength and durability at the elevated temperature. It also eliminated the need for a refractory material.

The new firebox was 25% smaller than the old one. The Stainless Steel has given superb performance, and sales have increased.

There have been no fabricating problems. National Heater uses the same equipment for Stainless Steel that they use for carbon steel.

No other metal combines the corrosion resistance, strength, appearance and easy fabricating properties of Stainless Steel. Keep this remarkable metal in mind when you plan a new design — and for top quality, specify service-tested USS Stainless Steel.

See "THE UNITED STATES STEEL HOUR," Televised alternate weeks. Consult your newspaper for time and station.

UNITED STATES STEEL CORPORATION, PITTSBURGH · AMERICAN STEEL & WIRE DIVISION, CLEVELAND
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO · NATIONAL TUBE DIVISION, PITTSBURGH
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS STAINLESS STEEL

SHEETS · STRIP · PLATES · BARS · BILLETS · PIPE · TUBES · WIRE · SPECIAL SECTIONS

UNITED STATES STEEL

AND NOW IN THE UNITED STATES

DALIC

PROCESS OF ELECTRODEPOSITION

The DALIC PROCESS of Electrodeposition provides a wide range of coatings on to most basis materials, including aluminum. It is particularly suitable for plating selected areas without stopping-off, for on-site work and for plating assemblies or components which may not be immersed in plating solutions.

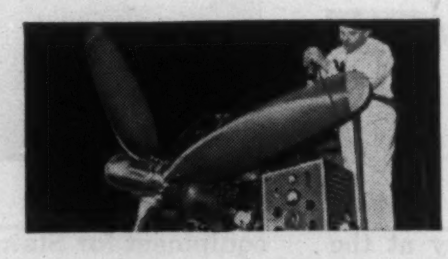
For such non-decorative purposes as building-up worn or over-machined parts, the extremely high speed of deposition and the accuracy with which deposit thickness can be controlled are most attractive features. Deposits are characterized by low stress, extremely fine grain, perfect adhesion and complete absence of porosity.

The DALIC PROCESS has received favourable acceptance by industry throughout Europe and installations have been made in the electronics, electrical, aircraft, automotive, armaments, radio and television industries and in various research establishments.

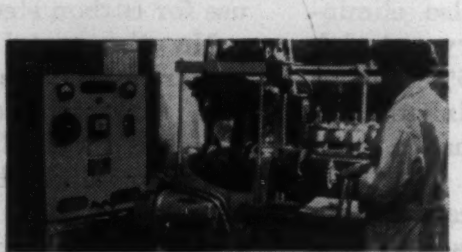
Deposit	Maximum Current Density Amp./ft. 2	Time to deposit 0.0001 in. * (secs.)	Brinell Hardness of deposits
Bismuth	1,500	7.6	50
Brass	—	—	—
Cadmium	6,000	2.5	40
Chromium	4,000	63.0	600
Cobalt	1,500	7.6	250
Copper	6,000	2.5	150
Gallium	1,000	17.8	—
Germanium	4,000	—	—
Gold	2,000	6.2	100
Indium	4,000	2.5	1
Iron	3,000	10.2	175
Lead	5,000	3.8	20
Nickel	5,000	5.1	500
Nickel (Black)	5,000	—	—
Palladium	1,500	10.2	150
Platinum	3,000	17.5	200
Rhodium	3,000	70.0	500
Silver	1,250	5.1	60
Thallium	2,000	12.6	—
Tin	5,000	2.5	1
Zinc	3,000	3.8	70

* On an area equal to the pad electrode used.

Leading edge of propellers being plated following wear.



Copper plating bore and keyway on pinion prior to carburizing.



Building up worn shafting.

DALIC METACHEMICAL LIMITED
121 LEICESTER AVE., TORONTO 18, CANADA
U.S.A. Distributors:
MARLANE DEVELOPMENT CO., INC.
153 E. 26th STREET, NEW YORK 10, N. Y.
MUrray Hill 5-9427

Associated Companies:

Metachemical Processes Ltd.
13 Strafford Road,
London W.3, England.

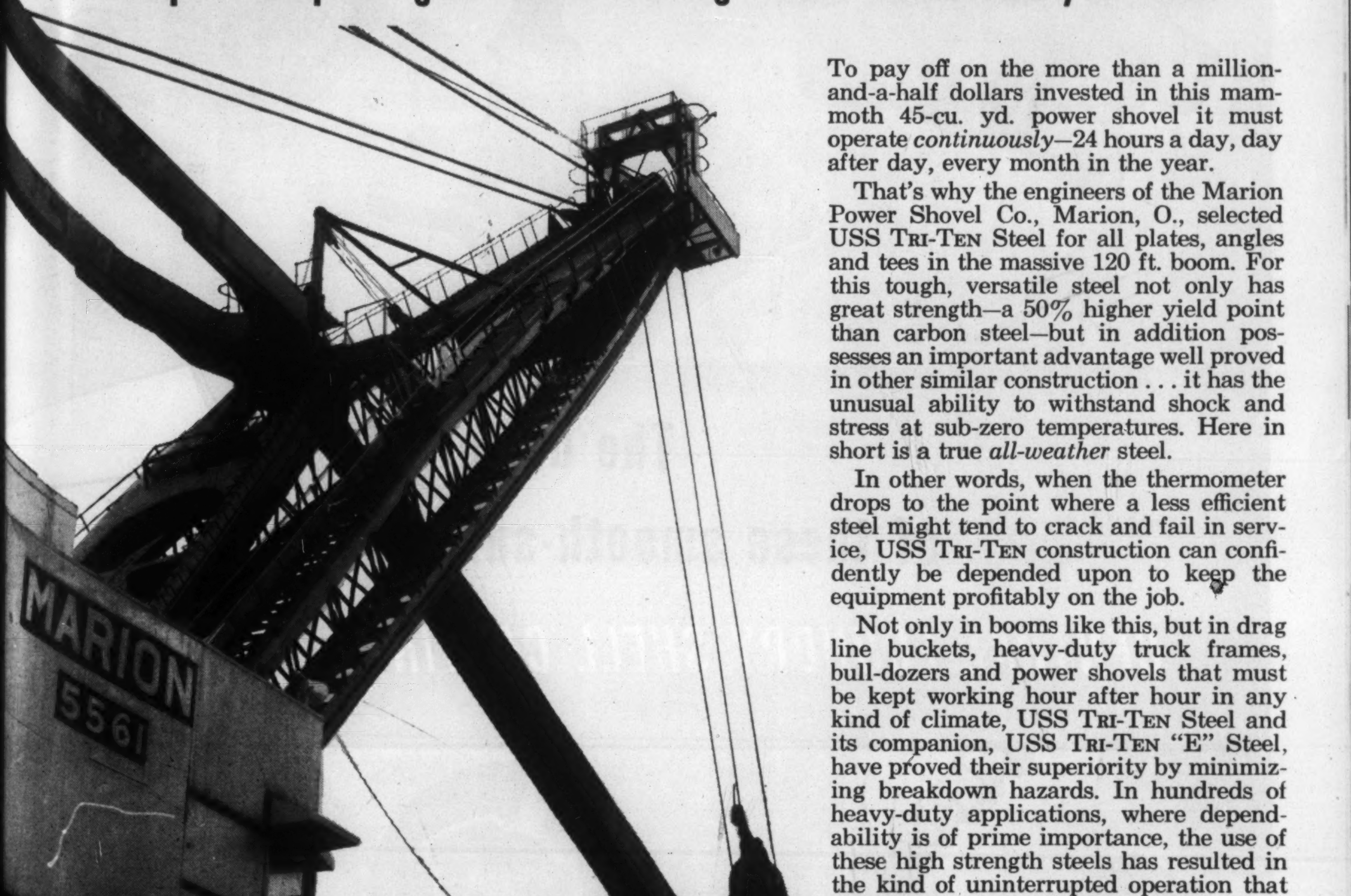
Laboratoires Dalic
29 Rue Dareau,
Paris XIV, France.

For more information, turn to Reader Service Card, Circle No. 472

For more Information, Circle No. 313 ➤

Massive boom built of USS TRI-TEN Steel

helps to keep this giant shovel working around-the-clock all year 'round



To pay off on the more than a million-and-a-half dollars invested in this mammoth 45-cu. yd. power shovel it must operate *continuously*—24 hours a day, day after day, every month in the year.

That's why the engineers of the Marion Power Shovel Co., Marion, O., selected USS TRI-TEN Steel for all plates, angles and tees in the massive 120 ft. boom. For this tough, versatile steel not only has great strength—a 50% higher yield point than carbon steel—but in addition possesses an important advantage well proved in other similar construction . . . it has the unusual ability to withstand shock and stress at sub-zero temperatures. Here in short is a true *all-weather* steel.

In other words, when the thermometer drops to the point where a less efficient steel might tend to crack and fail in service, USS TRI-TEN construction can confidently be depended upon to keep the equipment profitably on the job.

Not only in booms like this, but in drag line buckets, heavy-duty truck frames, bull-dozers and power shovels that must be kept working hour after hour in any kind of climate, USS TRI-TEN Steel and its companion, USS TRI-TEN "E" Steel, have proved their superiority by minimizing breakdown hazards. In hundreds of heavy-duty applications, where dependability is of prime importance, the use of these high strength steels has resulted in the kind of uninterrupted operation that spells bigger output at lower cost.

This machine is moving an average of well over 1,200,000 cu. yds. of overburden a month at the Wright Mine of the Boonville Collieries Corporation, subsidiary of Ayrshire Collieries Corp. of Indianapolis, Ind.

NOW AVAILABLE . . . Our new "Design Manual for High Strength Steels" is ready for distribution. This 174-page book is free. It contains comprehensive and practical information that you will find extremely useful in designing your equipment for greater economy and efficiency by the sound use of high strength steels. For your copy, write on your company letterhead giving your title or department, to United States Steel Corporation, Room 5029. 525 William Penn Place, Pittsburgh 30, Pennsylvania.

UNITED STATES STEEL CORPORATION, PITTSBURGH • AMERICAN STEEL & WIRE DIVISION, CLEVELAND • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
NATIONAL TUBE DIVISION, PITTSBURGH • TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. • UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
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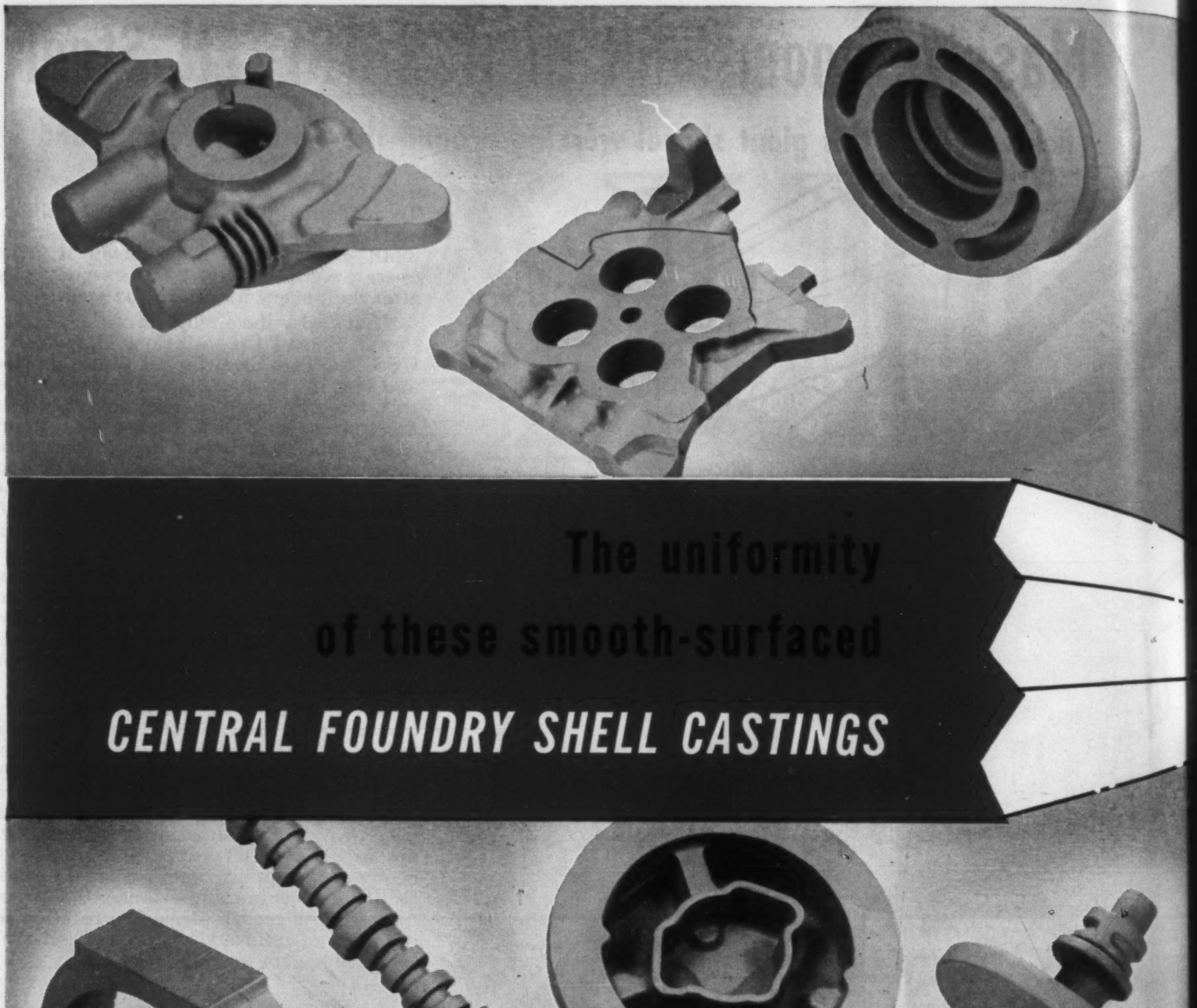
USS HIGH STRENGTH STEELS

USS TRI-TEN • USS COR-TEN • USS MAN-TEN

5-1834

UNITED STATES STEEL



In shell casting, the mold is formed by a thin shell of sand bonded by a thermo-setting plastic. This shell has a hard, smooth surface as accurate as the pattern itself. Shell casting has many advantages • complicated cast contours (impossible with the green sand process) are practical • uniformity with reduced finish allowances permits lower machining cost and longer tool life • improved casting surfaces, free from residual sand, often eliminate machining on non-functional areas and • lower casting weights effect savings in freight charges.

For further information about shell casting grey iron, malleable iron or Armasteel and how it may improve or effect economies in your product, write for descriptive literature . . . or request personal help from our experienced engineers, without obligation.

makes it possible to greatly
reduce machine cycle time
on these *FINISHED PARTS*

CENTRAL FOUNDRY DIVISION

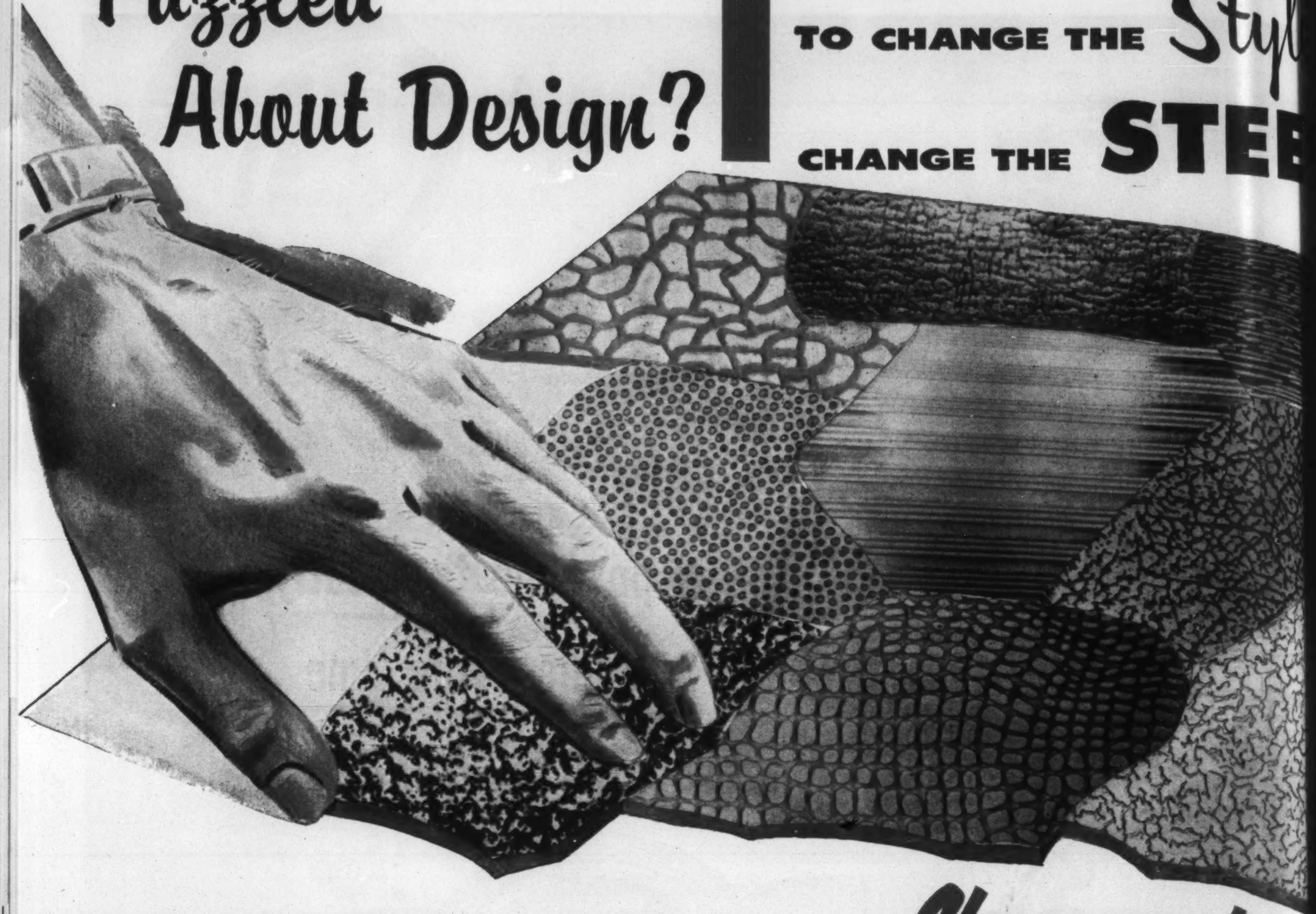
GENERAL MOTORS CORPORATION
SAGINAW, MICHIGAN • DEPT. 16

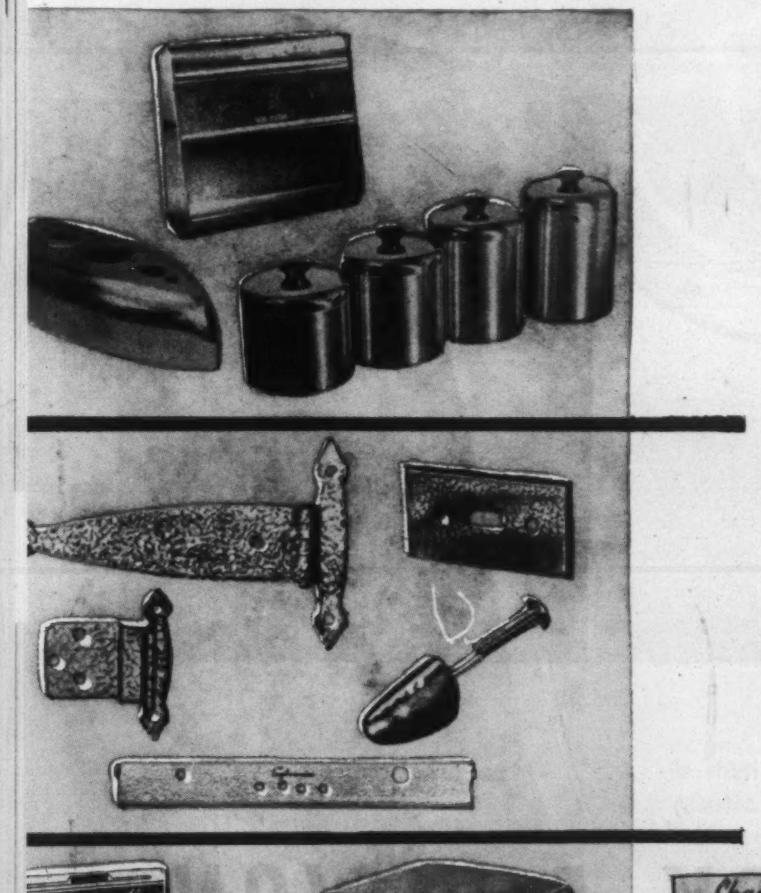
For more information, turn to Reader Service Card, Circle No. 419

Puzzled About Design?

TO CHANGE THE Styl

CHANGE THE STEE





SWITCH TO Sharonart

If your product is made of metal that must have eye appeal, should know about *Sharonart*—Sharon's amazing new surf rolled patterns in steel. May be painted or plated.

Many of the nation's leading product designers are already inclu ing these handsome patterns in their products of tomorrow. isn't necessary to alter the design of your product to achieve new look—simply change the style by changing the steel.

If you have a design problem, why not look into Sharonar A descriptive booklet is ready for you. Simply call the Shar office nearest you or write direct.

SHARONSTEEL

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Galvanite booklet ☐ Sharon 430 Stainless Steel Folder ☐

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Musk Ox
OVIBOS MOSCHATUS

Weatherproof

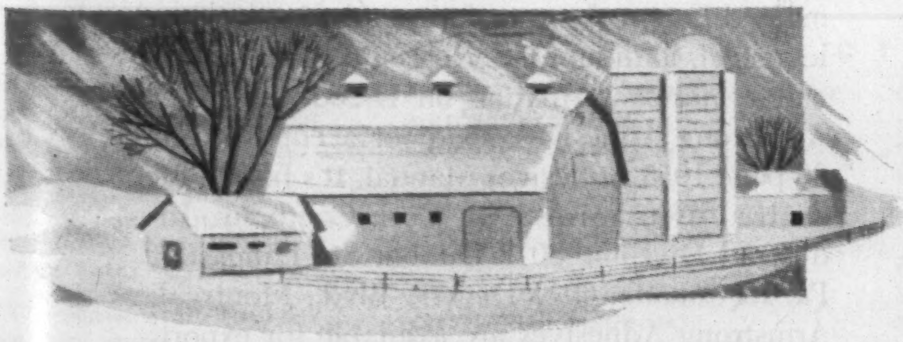
One of the most weatherproof of creatures in the world is the Musk Ox. In spite of the savage climate of their habitat (the tundra which rings the north polar sea), Musk Oxen do not migrate or hibernate, often pass their entire lives within a radius of a hundred miles.

A long, thick "overcoat" of hair protects the Musk Ox from the severe storms of winter and the ferocious flies of summer. A deep pad of wool next to his skin insulates him from the intense cold.

One of the most weatherproof of metals is aluminum. A tough oxide coating which forms naturally on an exposed aluminum surface is actually a weatherproof protection. It makes aluminum highly immune to the weathering and corrosive attacks of the elements which eat away other construction materials. Air and moisture do not affect the underlying metal.

Weatherproof, light and strong, aluminum is a versatile metal which is being used in the making of more and better products every day.

Aluminium Limited Sales, Inc. is the distributor in the United States for ALCAN aluminum from Canada. Why not investigate making your products of aluminum?



Weatherproof

In Farm, Residential and Commercial Buildings more and more aluminum is being used for its weatherproof superiority as well as its lightweight and high-strength advantages.

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Aluminum
from Canada

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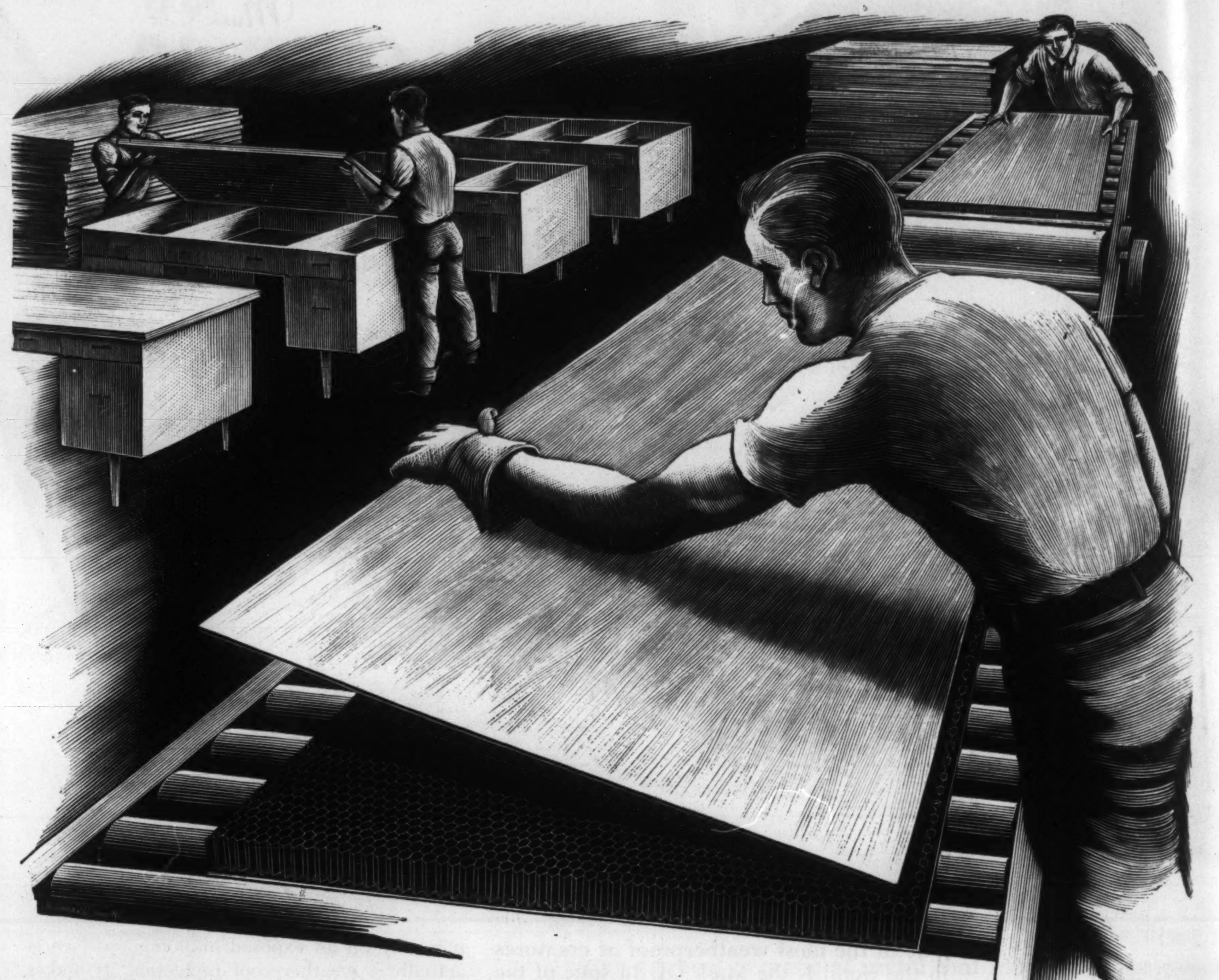

Turn out sandwich panels fast—
with this easy-to-use adhesive

The adhesive is Armstrong D-253—and it's made to order for positive high-speed bonding of sandwich panels on fast assembly lines.

D-253 is very easy to use. You can spray it on core and skin sheets, force dry it for one or two minutes, then assemble your sandwich. One pass through a pinch roll—and you've got a completed panel, ready for processing into such things as desk and table tops, flush doors, or office partitions.

Although D-253 is a thermoplastic adhesive, it has exceptionally high dead-load strength. It bonds sandwich panels firmly, permanently—and instantly. There's no time-consuming curing. The tough, flexible D-253 bond also has high shear strength, excellent resistance to moisture, and good resistance to heat.

Armstrong D-253 is versatile, too. With it, you can bond honeycomb or other cores to many different skins, including plywood, stainless steel, aluminum, and plastic laminates.

For more information on D-253 and other Armstrong Adhesives, send for a copy of our 36-page 1955 Adhesives Manual. It's free to industrial users. Armstrong Cork Company, Industrial Division, 8012 Dunbar St., Lancaster, Pa. In Canada, 6911 Decarie Blvd., Montreal. Armstrong Adhesives are available for export.

Armstrong

ADHESIVES • COATINGS • SEALERS

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SUCCESSFULLY BRAZED WITH

SILVALOY

LOW TEMPERATURE SILVER BRAZING ALLOY

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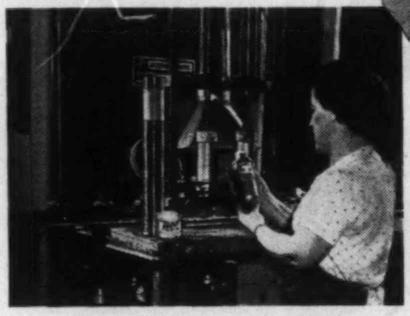
DRY
ANSUL
ANSUL
T-FLO
DRIER
ANSUL CHEMICAL CO. • MADE IN U.S.A.

The Ansul Dry-Eye system exemplifies outstanding efficiency in concept and design. It is a product of Ansul developmental research employing a T-flow principle for maximum drying efficiency and a special indicating element which tells at a glance the approximate moisture content of the refrigerant. It is quick and easy to install—and the cartridge can be replaced when required, in less than a minute. This is an important consideration in refrigeration manufacture and service.

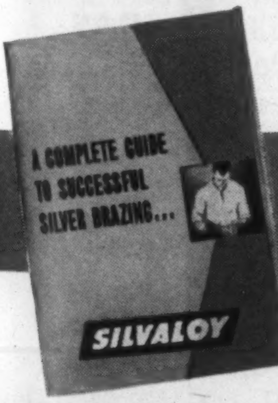
Production of the T-Flo Drier is kept at peak efficiency. Joints are brazed in an induction unit with Silvaloy preforms—a production procedure that assures positive, leakproof assemblies.

Low temperature Silver Brazing is helping to improve results, speed production and lower costs for manufacturers in many fields. Call the Silvaloy Distributor in your area for complete information or technical assistance. ★ ★ ★ ★ ★



Hex nut is Silvaloy brazed on cap which is in turn brazed to steel body. Air cylinder is used to hold spring-loaded parts in place in induction coil.

ANSUL



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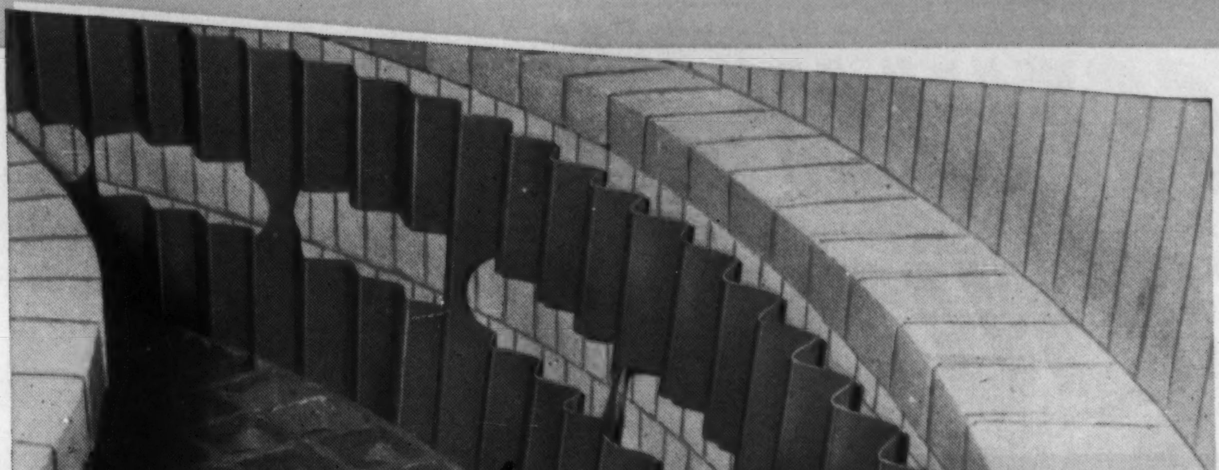
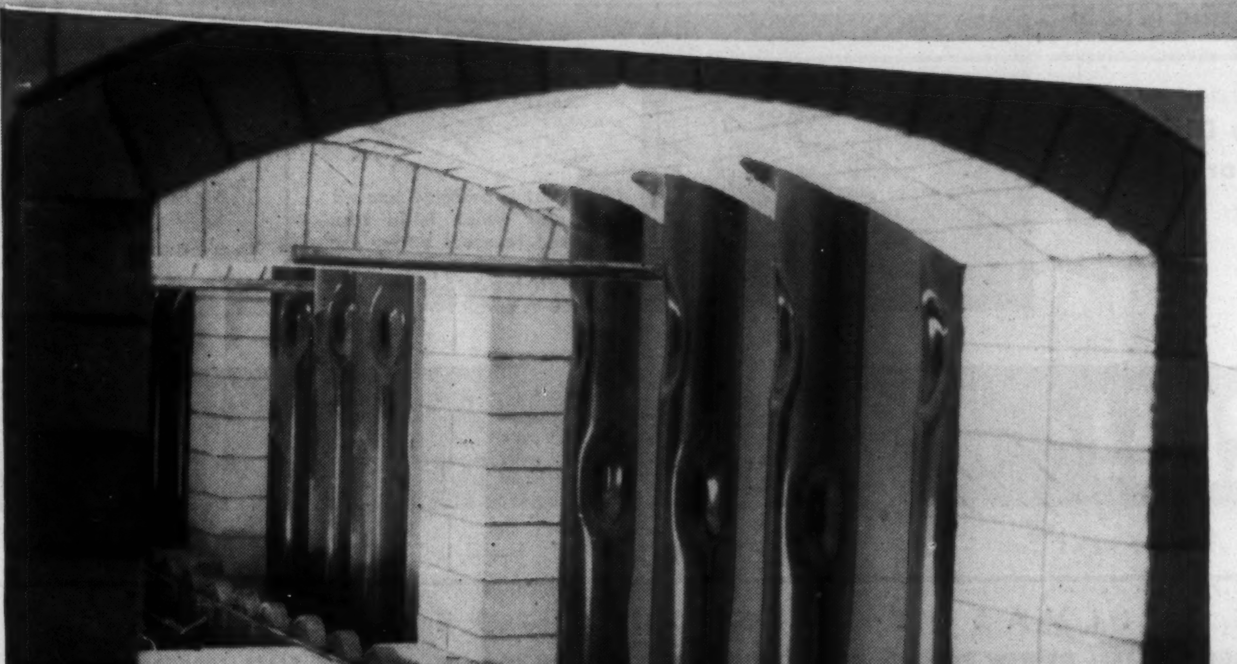
NOW AVAILABLE IN FIELD-ERECTED FURNACES



ELECTRIC

CORRTHERM elements are large corrugated sheets of nickel chromium and were developed in Lindberg laboratories by Lindberg metallurgists and engineers. At the left, installation of CORRTHERM elements in large rotary furnace currently being erected by Lindberg Industrial in plant of a leading automotive parts manufacturer.

FOR ELECTRIC FURNACES . . . FOR GAS FURNACES



GAS

The famous Lindberg "dimple" vertical radiant tube, designed by Lindberg engineers has proved its superior efficiency in hundreds of furnace installations since 1953. The photograph at the left shows its installation in a large pusher-type furnace built for a leading automotive manufacturer.

Lindberg Industrial Corporation is ready to serve these industries: Aluminum, Automotive, Building Supplies, Copper & Brass, Ceramics & Glass, Plastics, Pulp & Wood Products, Steel and many others.

LINDBERG

LINDBERG
INDUSTRIAL

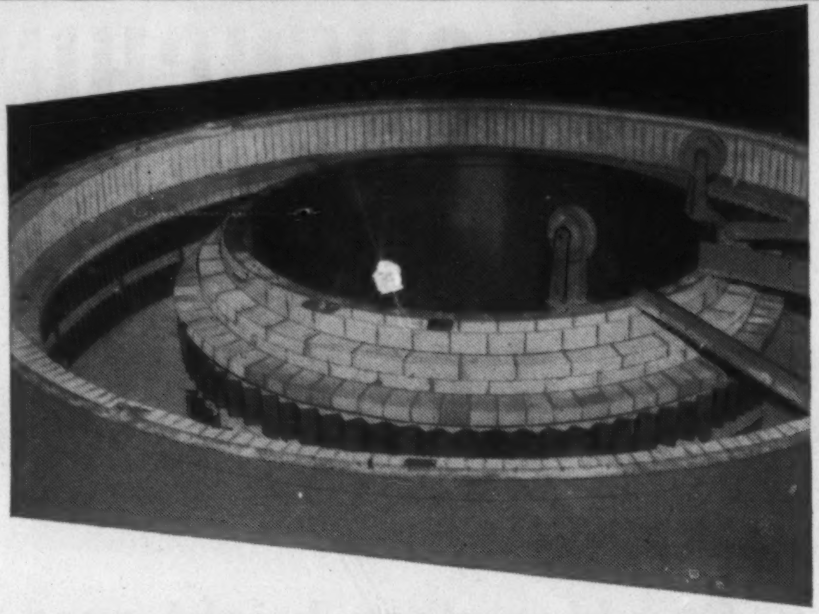
BY *LINDBERG INDUSTRIAL!*

Where source of heat is electricity!

CORRTHERM, Lindberg's radically advanced new electric heating element offers advantages never before available for heat treating furnaces. With this new element even carburizing and carbonitriding with electricity becomes practical, efficient and economical.

CORRTHERM elements operate at extremely low voltage. Consequently, leakage through carbon saturation and shock or short hazards are eliminated. Elements also act as baffles to direct circulation of convection streams.

CORRTHERM elements are practically indestructible. Work load or operator's charging tool can't hurt them. Watts density is at all time low. Easily installed or replaced, too, as element merely hangs in furnace and no complicated mountings are required.



A construction photo of one of two large rotary furnaces now being built by Lindberg Industrial for a leading automotive parts manufacturer. A section of this same furnace is shown on the opposite page.

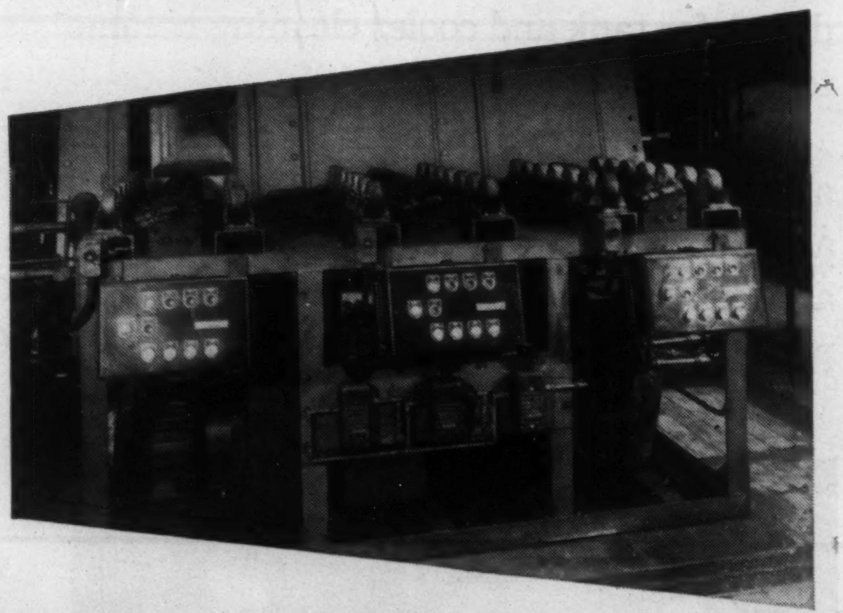
THE MOST ADVANCED HEAT ELEMENTS YET DEVELOPED

Where gas is the source of heat.

Because of Lindberg's revolutionary design, this tube provides a new level of furnace performance. The secret lies in the new Lindberg tube's "dimples." The tube carries a central stream of mixed air-and-gas surrounded by a cylindrical stream of air alone. Combustion occurs in the area between these two streams. The "dimples" create eddies accelerating combustion and maintaining even temperatures along the entire tube.

This Lindberg tube will operate at maximum efficiency for a longer period of time. The special protective coating gives greatest possible resistance to carbon penetration. Vertical position eliminates soot deposit and resultant temperature increases at points of sooting.

Tubes are just 59 inches long and weigh only 29 pounds, changeable in a few minutes. No costly furnace shut-downs and no high labor and material cost for tube changes.



This three-row pusher-type carburizing furnace provides maximum heat uniformity through use of Lindberg vertical radiant tubes installed between each row as well as at side walls, providing accurate control of case depth and properties. This highly efficient furnace with Lindberg vertical radiant tubes carburizes 650 lbs. of gears per hour with an effective case of .055".

INDUSTRIAL CORPORATION

Specialists in Field-erected Equipment

CHICAGO PLANT: 2321 WEST HUBBARD STREET, CHICAGO, ILLINOIS
LOS ANGELES PLANT: 11937 REGENTVIEW AVE., AT DOWNEY, CAL.

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Lindberg Industrial provides a complete consulting, designing and construction service including completed installation in your own plant. Call your nearest Lindberg Field Representative (see classified section of your telephone book) or write us direct.

SUN QUENCHING OIL NO. 11 LASTS FOUR TIMES LONGER THAN COSTLY COMPOUNDED OIL

Provides clean bright-quenched parts at lower cost ...keeps tanks and coolers cleaner longer

To get clean, bright-quenched parts, J. W. Rex Company, Lansdale, Pa., one of the foremost heat treaters in the country, had to drain their 1500-gallon quench tank every few weeks. High oil cost and frequent shutdowns for tank and cooler cleaning became too expensive.

A Sun representative made a thorough analysis of this problem. He then suggested a switch to Sun Quenching Oil No. 11—at a price about half that of the costly compounded oil they were using.

Now, *twelve months later*, the original charge of Sun Oil is still in the tank! Make-up is considerably lower...parts are continuing to come out clean and bright...and... tank maintenance costs are practically nil!

To find out how a Sun Quenching Oil can help *you* heat treat metal at lower cost, phone your local Sun representative or write for Sun's latest Technical Bulletin containing complete information about Sun Quenching Oil No. 11. Address Sun Oil Company, Philadelphia 3, Pa. **Dept. ML-12.**

J. W. Rex, right, President of J. W. Rex Co. and Sun representative check brightness of an intricate 8620 steel part after quench in Sun Quenching Oil No. 11.

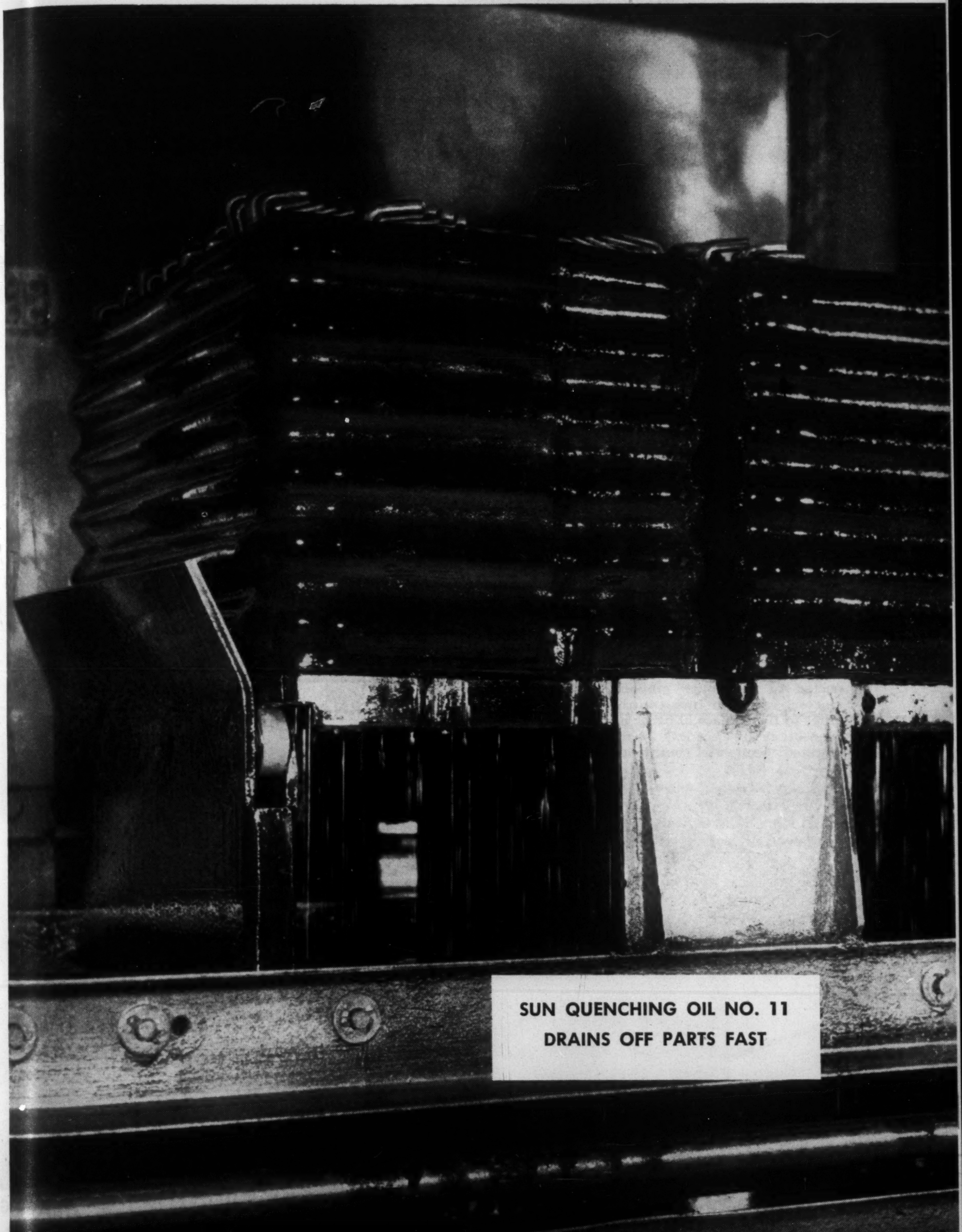
SUNOCO

INDUSTRIAL PRODUCTS DEPARTMENT

SUN OIL COMPANY

Philadelphia 3, Pa.

In Canada: Sun Oil Company Ltd., Toronto and Montreal


SUN QUENCHING OIL NO. 11
DRAINS OFF PARTS FAST

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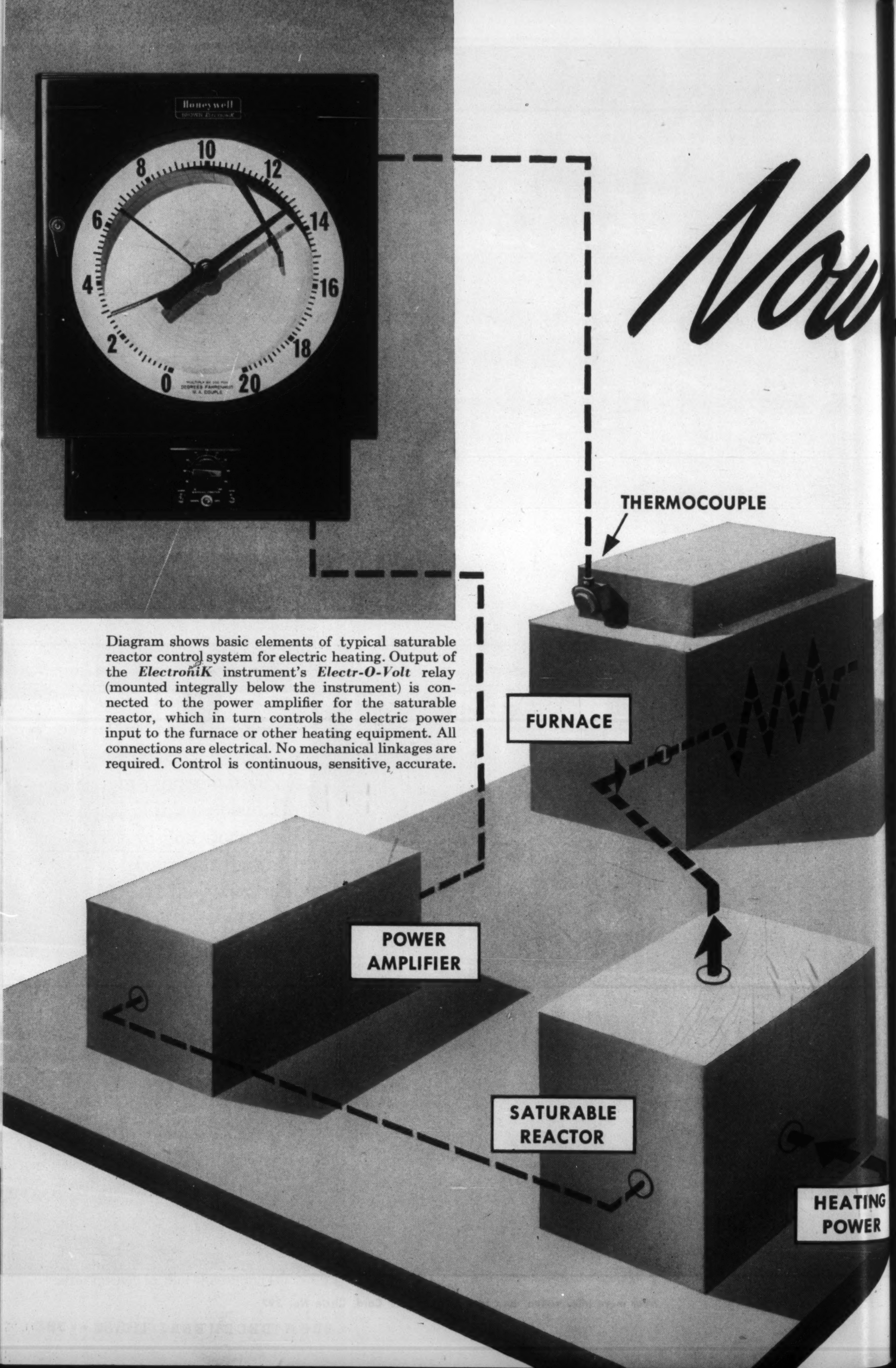
Honeywell
BROWN ELECTRONIK
0
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FURNACE
POWER AMPLIFIER
SATURABLE REACTOR
HEATING POWER
Now

Diagram shows basic elements of typical saturable reactor control system for electric heating. Output of the ***ElectroniK*** instrument's ***Electr-O-Volt*** relay (mounted integrally below the instrument) is connected to the power amplifier for the saturable reactor, which in turn controls the electric power input to the furnace or other heating equipment. All connections are electrical. No mechanical linkages are required. Control is continuous, sensitive, accurate.

continuous, accurate control of electrically heated equipment

ElectroniK instrumentation with Electr-O-Volt* relay provides continuous throttling in saturable reactor control systems

You can now regulate temperatures of electrically heated furnaces, ovens, and similar processing equipment within exceptionally close tolerances, by using an advanced *ElectroniK* control system in conjunction with saturable reactors. This type of control eliminates the abrupt surges of power and the expense of contact replacement which are frequently objectionable factors of on-off or pulsed electric control.

Continuous control action. The *Electr-O-Volt* relay, actuated by the *ElectroniK* instrument, provides continuously variable control input to the saturable reactor power amplifier. This arrangement gives true proportional-plus-reset control action, which adjusts heat input to compensate for size of load, ambient temperature and other transient and long-term variations in heat demand.

Completely electronic. The system has no mechanical linkages, contactors, or other complex moving parts. Its high speed and sensitivity give the precise control required by modern processes.

Broad range of use. *ElectroniK* control for saturable reactors is applicable to high-temperature heat-treating furnaces, reaction vessels and many other types of electrically heated equipment. It makes possible smooth, finely-adjusted regulation of electric power at high efficiency.

For a discussion of how this control can be applied to your specific problems, call your local Honeywell sales engineer. He's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

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● **REFERENCE DATA: Write for Catalog 1531, "*ElectroniK* Controllers," and for new Bulletin 8420, "*Electr-O-Volt* Relay."**

H HONEYWELL

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls

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• *Stymied by a*

High-Temperature Barrier?

• *Looking for a*

High-Purity Material?

• *Searching for a material with*

Unusual Electrical Characteristics?

You may find the answer in this new booklet on NORTON Refractory Grain

NORTON
Refractory Grain
Electrochemically Refined
Engineered R Prescribed
ALUNDUM
Fused Alumina
Al₂O₃
Type: E 163
Type: RR
CRYSTOLON
Silicon Carbide
SiC
Type: Regular
NORTON REFRACTORY GRAIN
... for Industry

This latest Norton publication is 8½" x 11". Twenty-four pages, with many charts, tables and photographs in color. A wealth of practical information on the nature, performance and application of refractory grains.

If you're concerned with industrial processing involving temperatures ranging upwards to 4000°C and materials to contain your inferno — if you're looking for a high-purity material such as high-purity fused alumina for coating electronic heater filaments — if you're searching for a material with unusual electrical characteristics such as E 179 CRYSTOLON* Silicon Carbide for lightning arrestors — one of the many types of Norton Refractory Grain available may solve your problem.

This new booklet describes in detail Norton Refractory Grain — produced and purified in electric arc and high temperature resistance furnaces — which is helping industry to improve existing products and processes and to create new ones.

It's a valuable reference book with up-to-the-minute information on the chemical and physical characteristics of such materials as CRYSTOLON* Silicon Carbide, ALUNDUM* Aluminum Oxide, MAGNORITE* Magnesium Oxide, Fused Zirconia and Boron Carbide. In it you'll find data on how these materials are produced; their behavior under varying conditions; available grain size and applications.

These electrochemically refined materials may be just what you've been looking for to solve your problem. Write today for your free copy of "Norton Refractory Grain." NORTON COMPANY, Refractories Division, 354 New Bond Street, Worcester 6, Mass.

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REFRACTORIES

Engineered... R... Prescribed

Making better products... to make your products better

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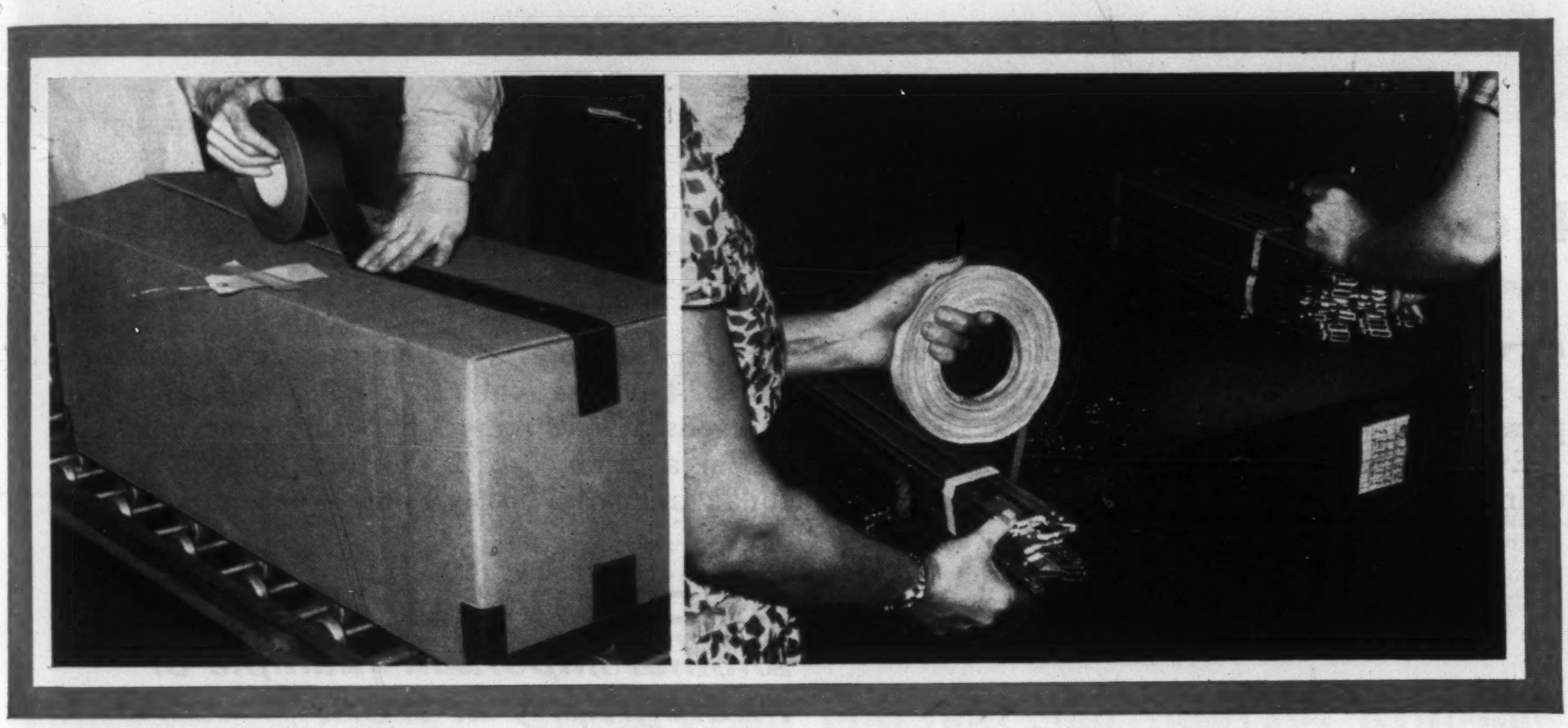
Polyken TAPES

CONTROLLED STRENGTH

Do double duty at no extra cost



The container in the picture above holds an aircraft heater which is shipped in two cartons—one inside the other.

Formerly one kind of tape was used to seal the inner carton, another for the outer. Sometimes the two tapes were switched—an expensive error.

Durable *Polyken* Waterproof Tape now does *both jobs—at no extra cost.* In fact, packaging costs are reduced, since the cartons are sealed more securely and there's no chance of using the wrong tape.

Polyken Tape also does an extra job in the right-hand picture. The operator in front is using it to bundle aluminum door rails. The other operator is marking the tape for identification. *Polyken* Tape was chosen here for both jobs because it's economical, easy to handle, comes off clean—and saves the time and cost of tags.

The tape requirements for these jobs are not the same. Neither are the conditions under which they are used. To meet the requirements for specific jobs, *Polyken* Tapes have *controlled strength*—the proper combination of adhesive and backing. You get the *controlled strength* needed for your job. It's done right and it's done without waste.

Send coupon for full details.

Polyken®

INDUSTRIAL TAPES

Polyken Products Department of The Kendall Company

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Please send me physical properties and further information on *Polyken* Controlled Strength Tapes.

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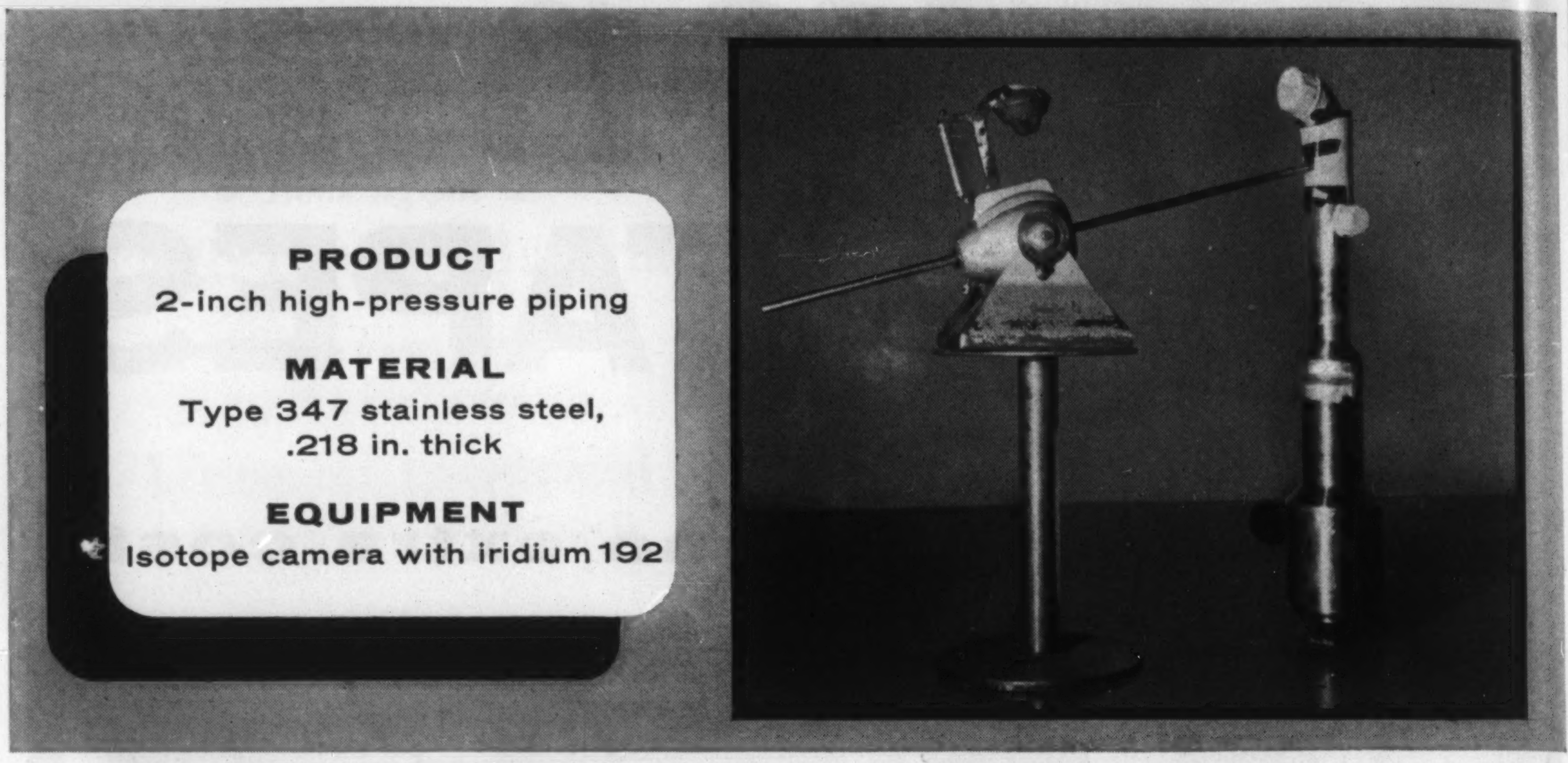
What's the Right X-ray Film?


PRODUCT
2-inch high-pressure piping
MATERIAL
Type 347 stainless steel,
.218 in. thick
EQUIPMENT
Isotope camera with iridium 192

Kodak Industrial X-ray Film, Type A

THIS PIECE of piping will become part of a critical system where temperatures and pressures mount high.

Every joint in it is welded—then radiographed to insure soundness.

For these exposures the radiographer uses iridium 192 having a source strength of 3200 milliroentgens at one meter. Exposure time is 90 secs. at a distance of 2¼ inches. The film is Kodak Industrial X-ray Film, Type A.

RADIOGRAPHY . . .

another important example of Photography at Work

THERE'S A RIGHT FILM FOR EVERY PROBLEM

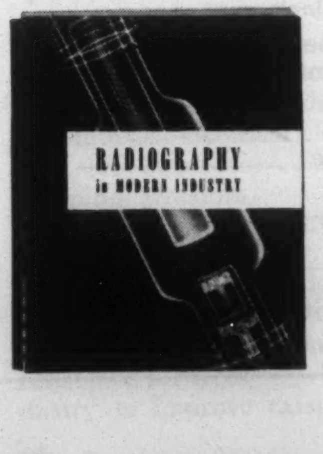
Whatever your radiographic problem, you'll find the best means of solving it in one of Kodak's four types of industrial x-ray film. This choice provides the means to check castings and welds efficiently, offers optimum results with varying alloys, thicknesses and radiographic sources.

Type A—has high contrast and fine graininess with adequate speed for study of light alloys at low voltage—heavy parts at intermediate and high voltages. Used direct or with lead-foil screens.

Type F—provides the highest available speed and contrast when exposed with calcium tungstate intensifying screens. Has wide latitude with either x-rays or gamma rays when exposed directly or with lead screens.

Type K—has medium contrast with high speed. Designed for gamma ray and x-ray work where highest possible speed is needed at available kilovoltage without use of calcium tungstate screens.

Type M—provides maximum radiographic sensitivity with direct exposure or lead-foil screens. It has extra-fine grain and, though speed is less than Type A, it is adequate for light alloys at average kilovoltages and for much million- and multi-million-volt work.



RADIOGRAPHY IN MODERN INDUSTRY

A wealth of invaluable data on radiographic principles, practice, and technics. Profusely illustrated with photographs, colorful drawings, diagrams, and charts. Get a copy from your local x-ray dealer—price, $3.

EASTMAN KODAK COMPANY
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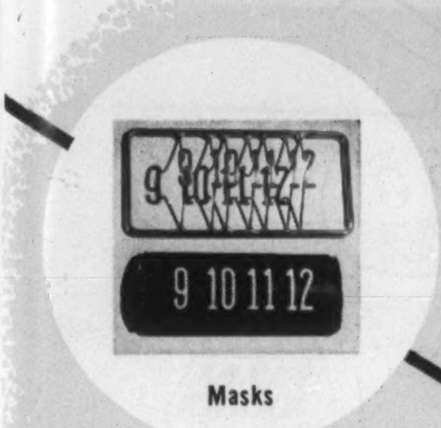
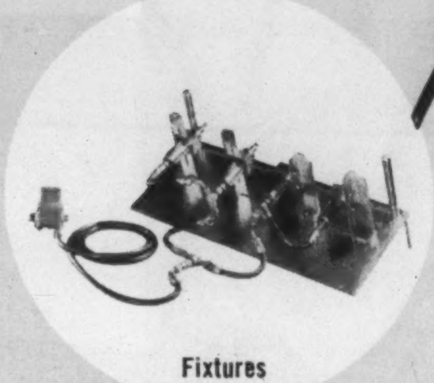


Masks

Conforming Matrix spray painting masks withstand thousands of applications, a complete year's run of high production. Plug-type keeps depressed areas clear while spraying background; lip-type protects background while painting depressed areas; block-cutout, plane-surface type coats restricted area for fast wiping operation; cap-type protects raised design while painting background.



Fixtures

Standard and special clamps and pressure fixtures hold mask and part firmly in position during spraying to assure exact registration. Reduce rejects, lengthen mask life, and speed production by freeing both hands for productive movements. Usually cost less than hand-made mechanical devices of questionable efficiency.

PRODUCT DEVELOPMENTS BY CONFORMING MATRIX

CM

Mask Washing Machines

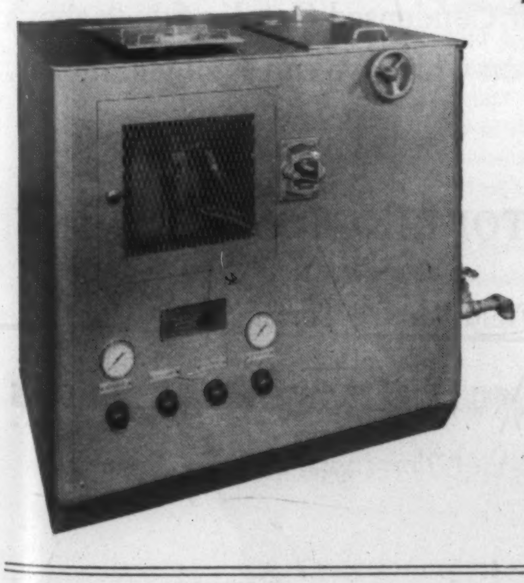
50% faster than any other mask washer. Avert costly production delays due to damaging of the fine wire bridging by hand scrubbing. Low solvent consumption. One company reports the consumption of only two gallons per eight hours.

Don't

LET OLD FASHIONED, OBSOLETE METHODS OF SPRAY DECORATING STEAL YOUR PROFITS!

Cut finishing costs. Greatly increase production with Conforming Matrix spray masks, fixtures, automatic machines and mask washers. Send prints or sample parts, giving production requirements and results desired. Recommendations as to the most efficient technique for handling your particular requirements incur no obligation.

Automatic machines permit increased production rates in intricate spray mask decoration, by as much as hundreds to one, over hand methods. Radically reduce labor costs and eliminate the need of experienced workmen. Rejects, common with careless or inexperienced hand spraying, are practically eliminated. Conforming Matrix builds a number of very flexible automatic machines, each can be manufactured to meet your specific requirements.



OSCILLATING GUN PRESSURE CONTACT PAINTING MACHINE COMBINING MASK WASHING FACILITIES

The only machine which permits the gun to operate in a stationary position as well as in a concave arc, or pendulum-type swing, and which has an integrated agitator type mask washer. Completely air operated. The cam controlling the oscillating stroke is adjustable and can paint areas up to 11″ x 8″.

Self-contained and completely enclosed. The paint cycle is actuated by downward movement of the piece part and mask. Working mechanism completely covered from overspray. The oscillating mechanism is fully adjustable as well as spray gun and paint cycle. Only 900 C.F.M. required to exhaust. ¼ H.P. is sufficient.

By utilizing a built-in mask washer a 10% to 20% increase in production can be achieved over the use of a separate washer, or washing masks by hand. It furthermore eliminates the necessity of blowing off or drying the masks before using, as it has a mechanical elevating mechanism which furnishes clean dry masks to the operator.

CONFORMING MATRIX CORPORATION

386 Toledo Factories Building **Toledo 2, Ohio**

Please send without obligation, details on
☐ ***Masks;*** ☐ ***Fixtures;*** ☐ ***Mask Washing Machines;*** ☐ ***Automatic Machines.***

NAME____________________
FIRM____________________
STREET____________________
CITY & STATE____________________

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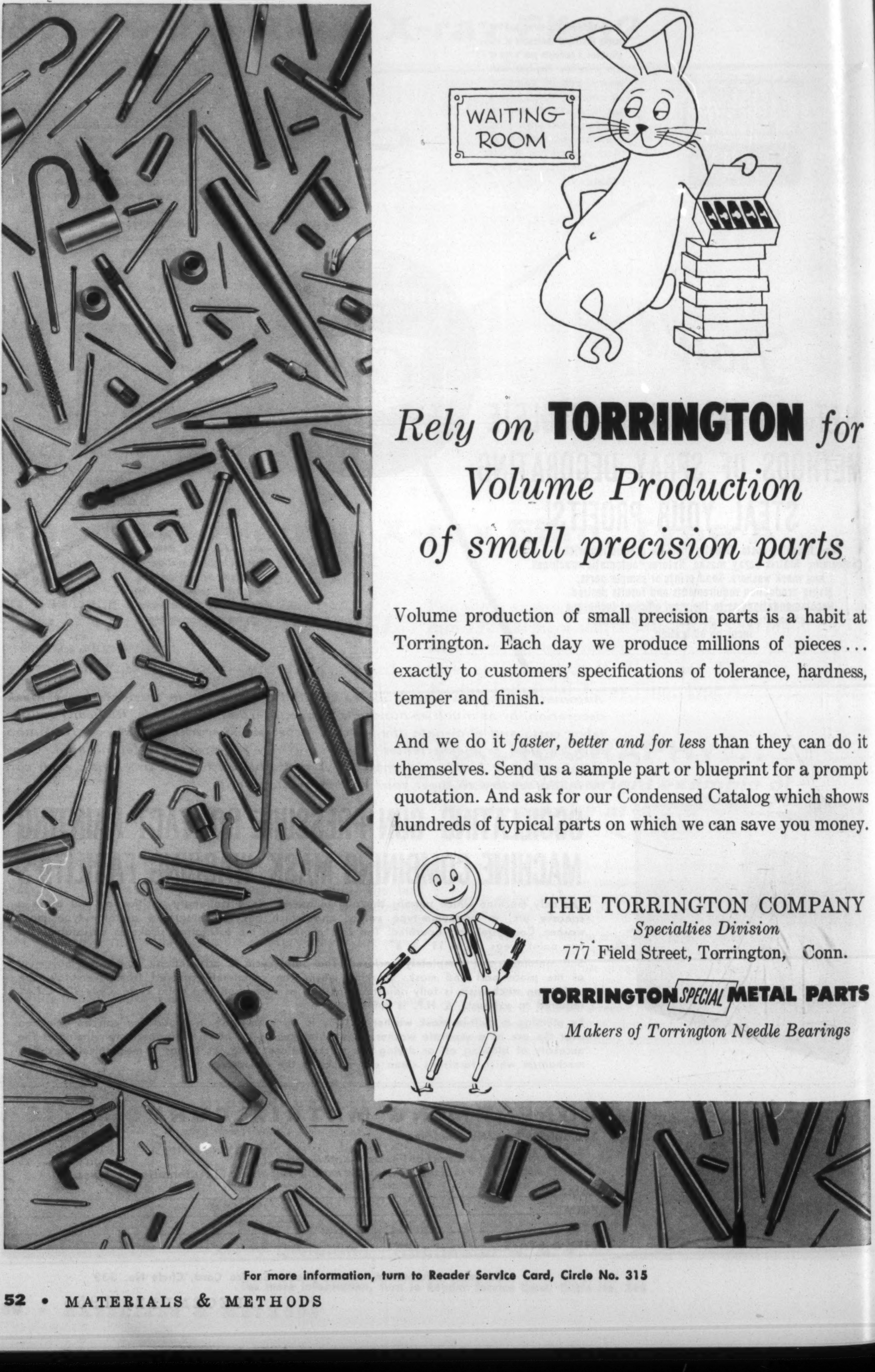

Rely on **TORRINGTON** *for Volume Production of small precision parts*

Volume production of small precision parts is a habit at Torrington. Each day we produce millions of pieces... exactly to customers' specifications of tolerance, hardness, temper and finish.

And we do it *faster, better and for less* than they can do it themselves. Send us a sample part or blueprint for a prompt quotation. And ask for our Condensed Catalog which shows hundreds of typical parts on which we can save you money.

THE TORRINGTON COMPANY
Specialties Division
777 Field Street, Torrington, Conn.

TORRINGTON *SPECIAL* METAL PARTS

Makers of Torrington Needle Bearings

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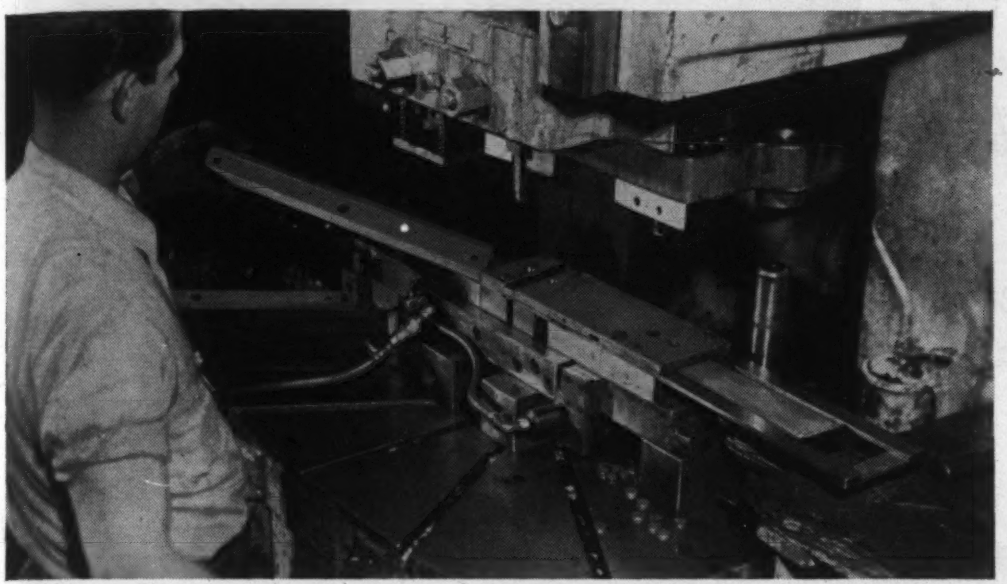
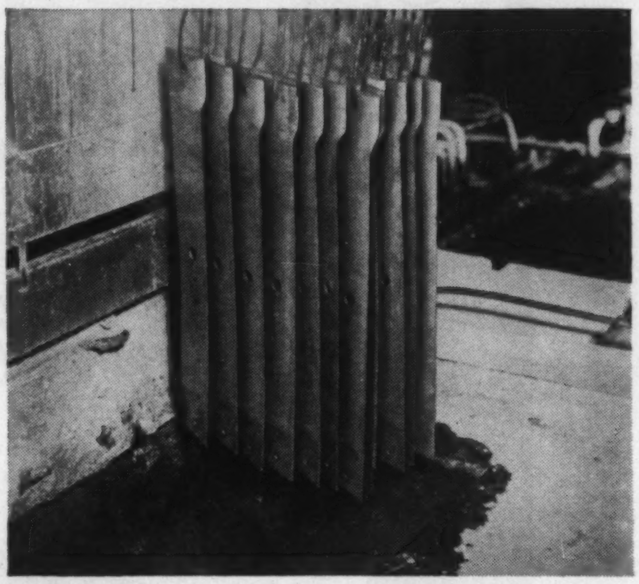
GENUINE
LAWN-BOY
MOWER BLADE

Cutter blade of Crucible alloy steel.



First step in manufacture of cutter blade. Crucible beveled blade alloy steel is fed through this 100-ton press, where it is cut to length and holes punched.



Next, lengths are formed to shape on a hydraulic press, and then given a tempering bath as shown.

CRUCIBLE ALLOY STEEL *cuts blade damage in rotary mowers . . .*

Lawn-Boy mower. Built by RPM Manufacturing Co., Lamar, Mo., a subsidiary of Outboard, Marine & Manufacturing Company, maker of Johnson & Evinrude outboard motors.

Rotary lawnmower cutter blades, whirling at high speeds, often hit small rocks or bits of trash. Ordinary steels just can't take that sort of rugged treatment. They chip, crack — wear out far too quickly. That's why in leading mowers, like the new *Lawn-Boy*, you'll find special *alloy* steel cutter blades *designed for reliable performance.*

For Crucible has developed a *special alloy steel* made to give the best possible combination of toughness and hardness for long-lasting edges—and formability and ductility for ease of manufacture. It's been so successful that *Crucible is now the largest producer of lawnmower steels.*

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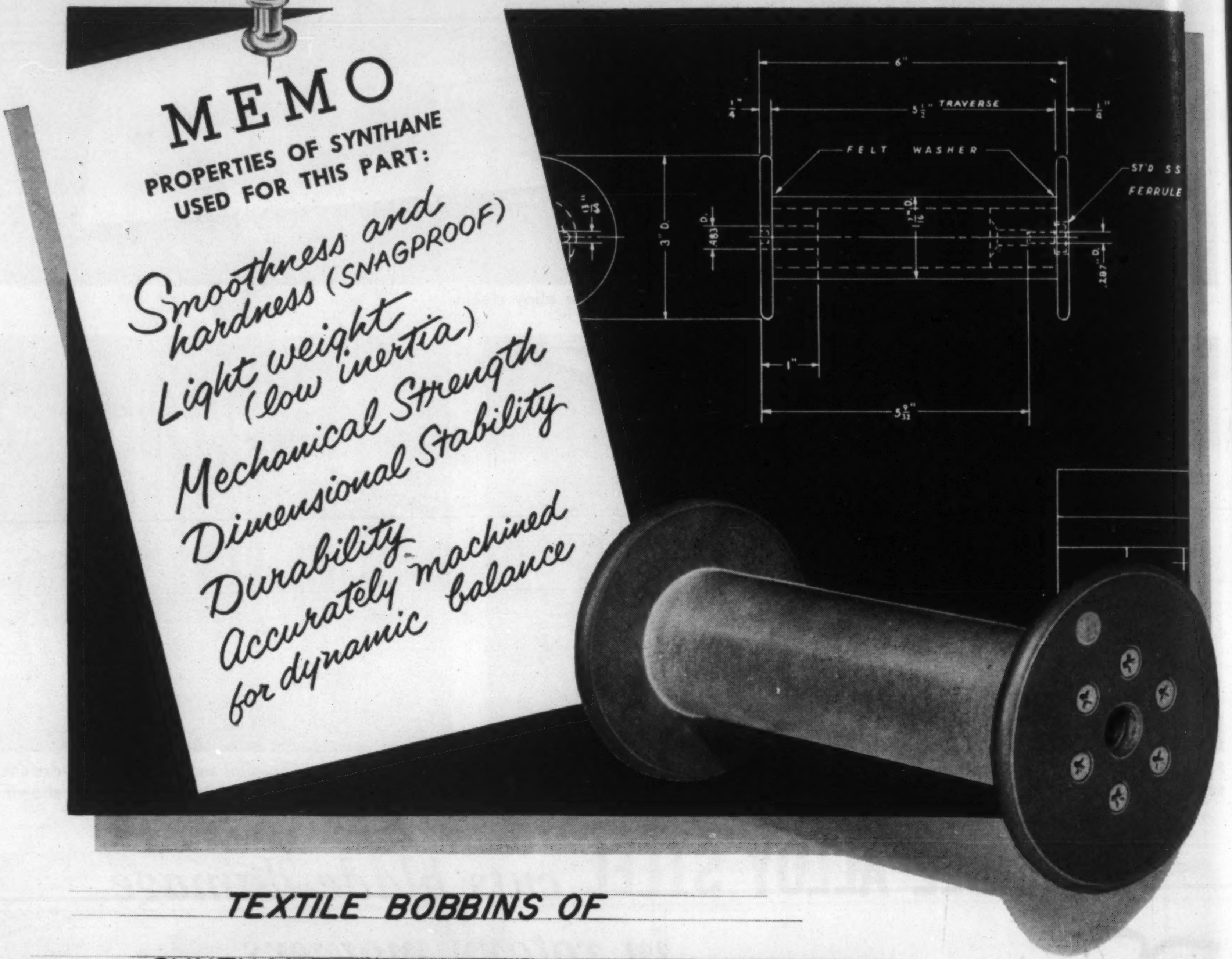
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PROPERTIES OF SYNTHANE USED FOR THIS PART:
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Dimensional Stability
Durability
Accurately machined for dynamic balance
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5 1/2" TRAVERSE
FELT WASHER
ST'D SS FERRULE
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.483 D.
.187 D.
1"
5 9/32"

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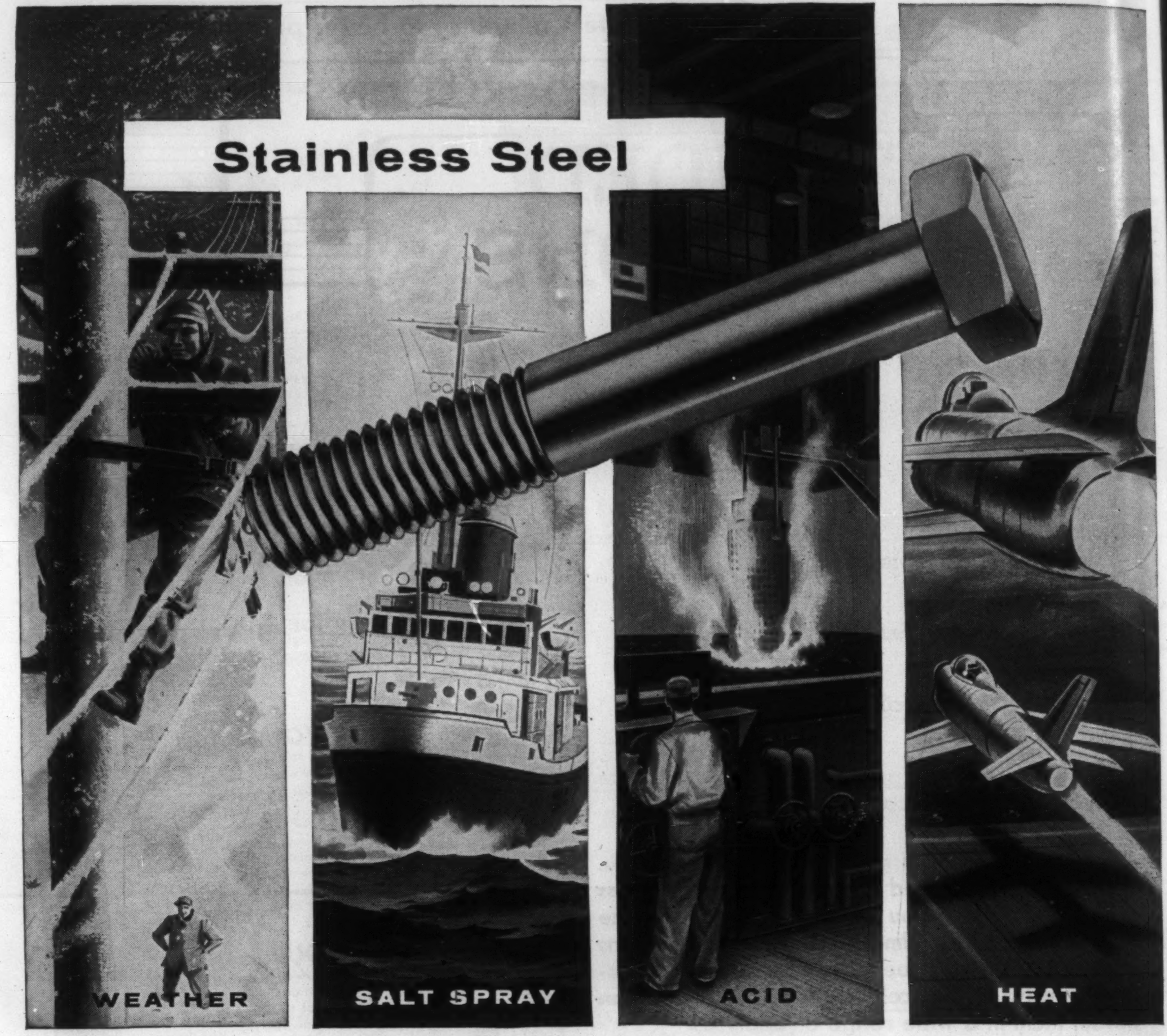

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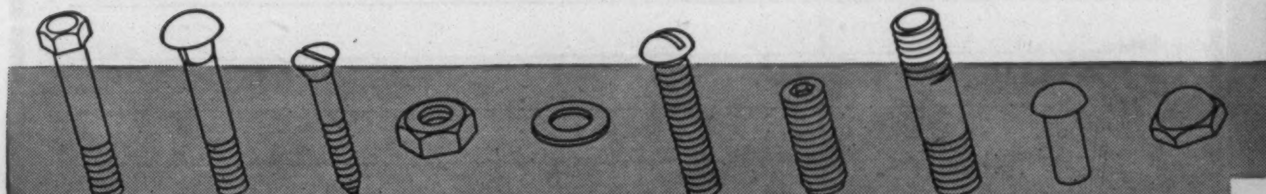

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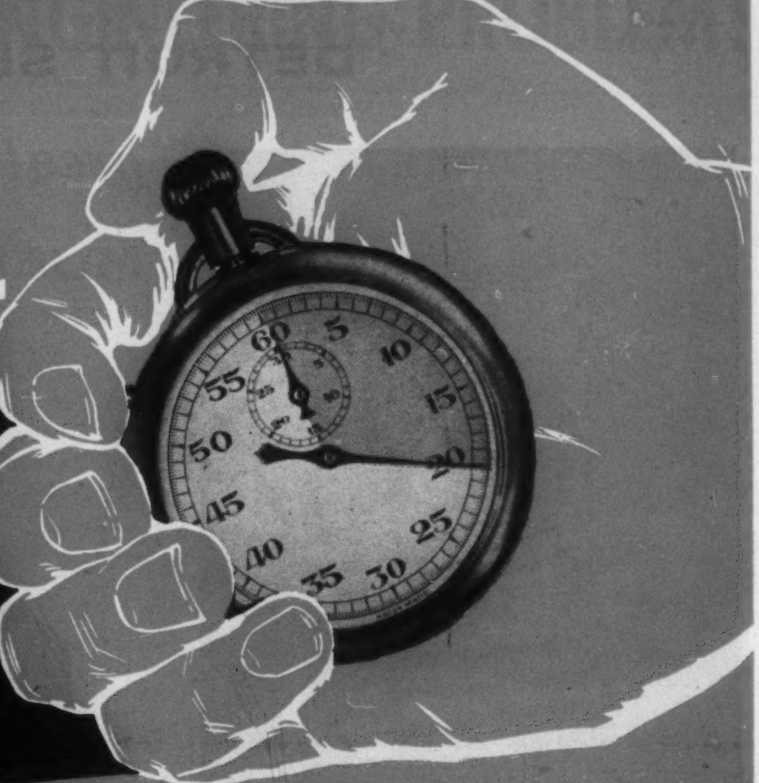

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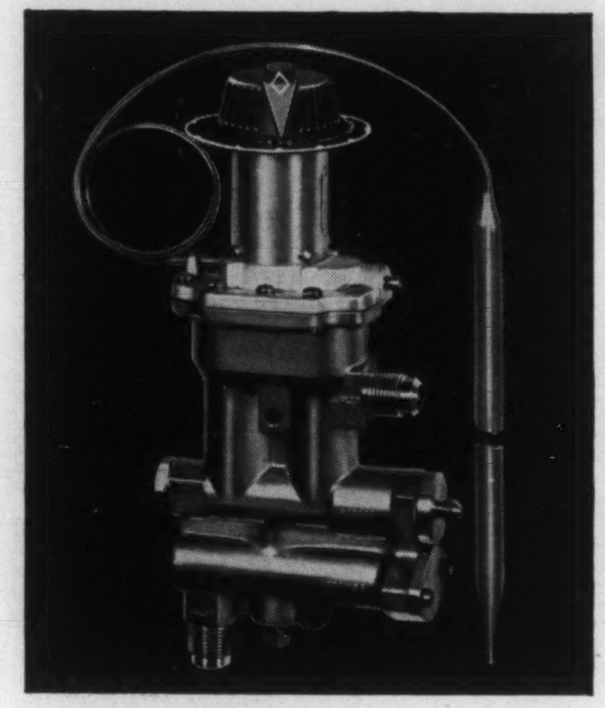

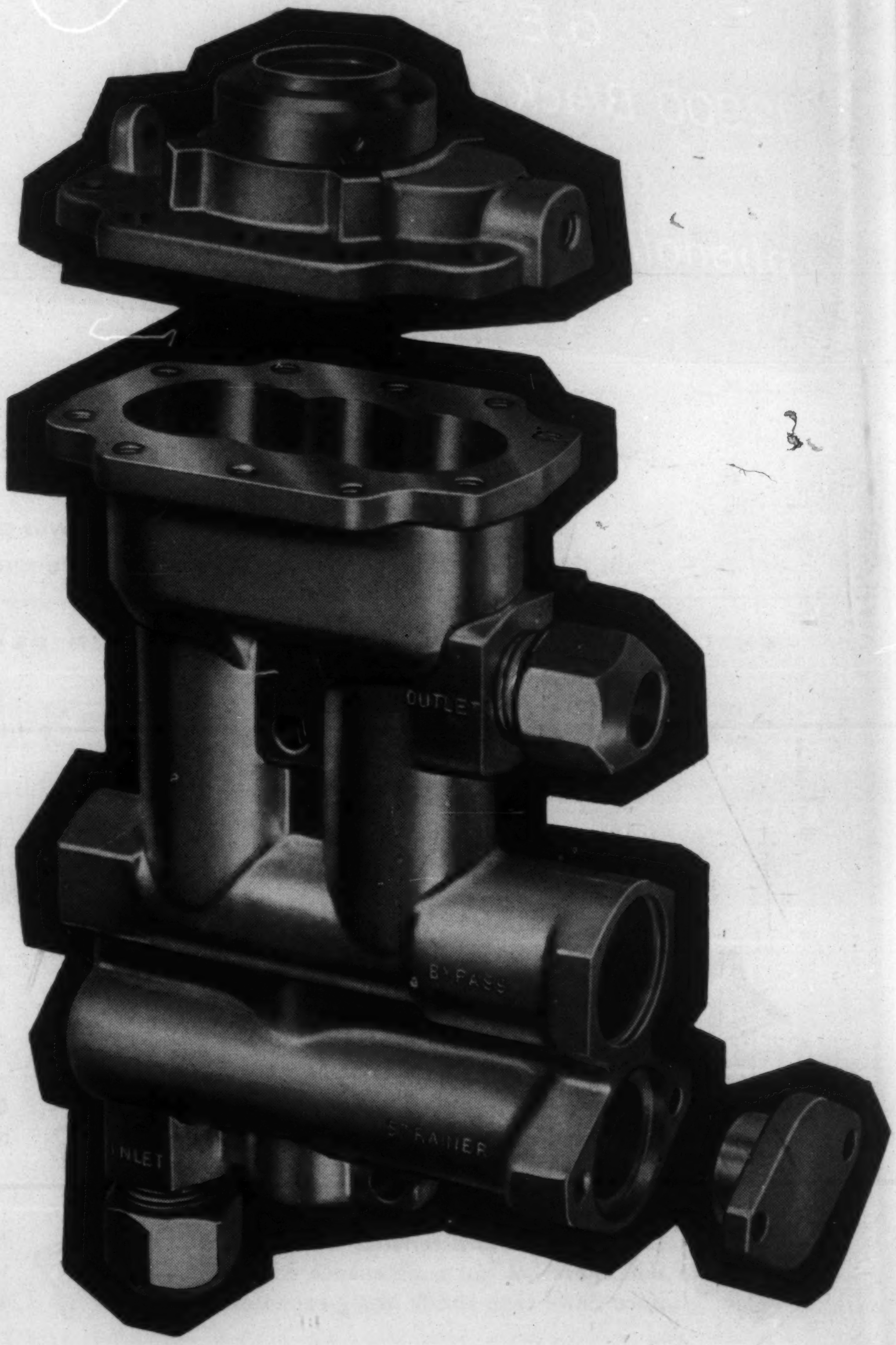

One of the finest thermostat control mechanisms for year-around air-conditioning systems is the automatic SELECTAFLOW, a product of the Detroit Controls Corporation. To maintain the high quality of this efficient unit and at the same time speed up and simplify assembly, the body, bonnet and side cover are being forged and completely machined to close tolerances by the Mueller Brass Co. In all, thirty-four machining and finishing operations are performed. This is but one more example of how Mueller Brass Co. machined forgings have improved a product and speeded production. With a wide range of copper-base alloys for forgings, a tremendous background of product engineering, and facilities for precision finish machining, the Mueller Brass Co. can supply machined brass or bronze forgings to *your exact specifications*. It will pay you to consider Mueller Brass Co. forgings for your new or redesigned products. Write us for full color catalog and technical information.

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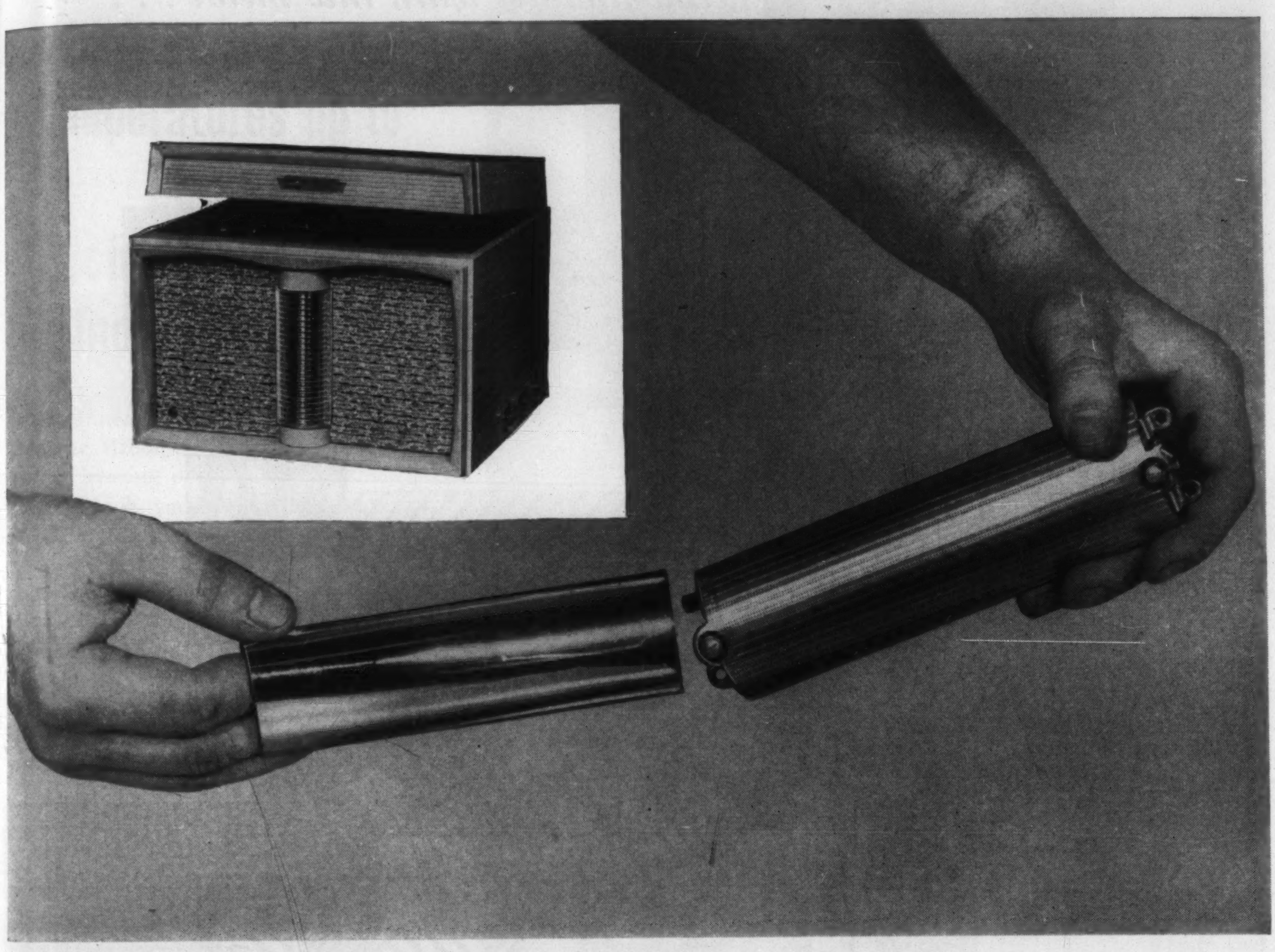

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"Our new electrostatic high-fidelity speaker couldn't have been developed without Du Pont 'Mylar,' " reports the Philco Corporation. "We use metalized 'Mylar' to obtain an extremely thin, strong diaphragm that both insulates and conducts current on the same material. Fitted over an aluminum backplate, 'Mylar' operates at frequencies where ordinary diaphragms would be badly deformed—'Mylar' gives us completely undistorted sound."

This successful product innovation is only one example of the way an imaginative industry is putting the unique properties of "Mylar" polyester film to profitable use. From metallic yarns to smaller transformers for guided missiles, Du Pont "Mylar" is making possible better products at lower cost in a wide variety of fields. Here's why:

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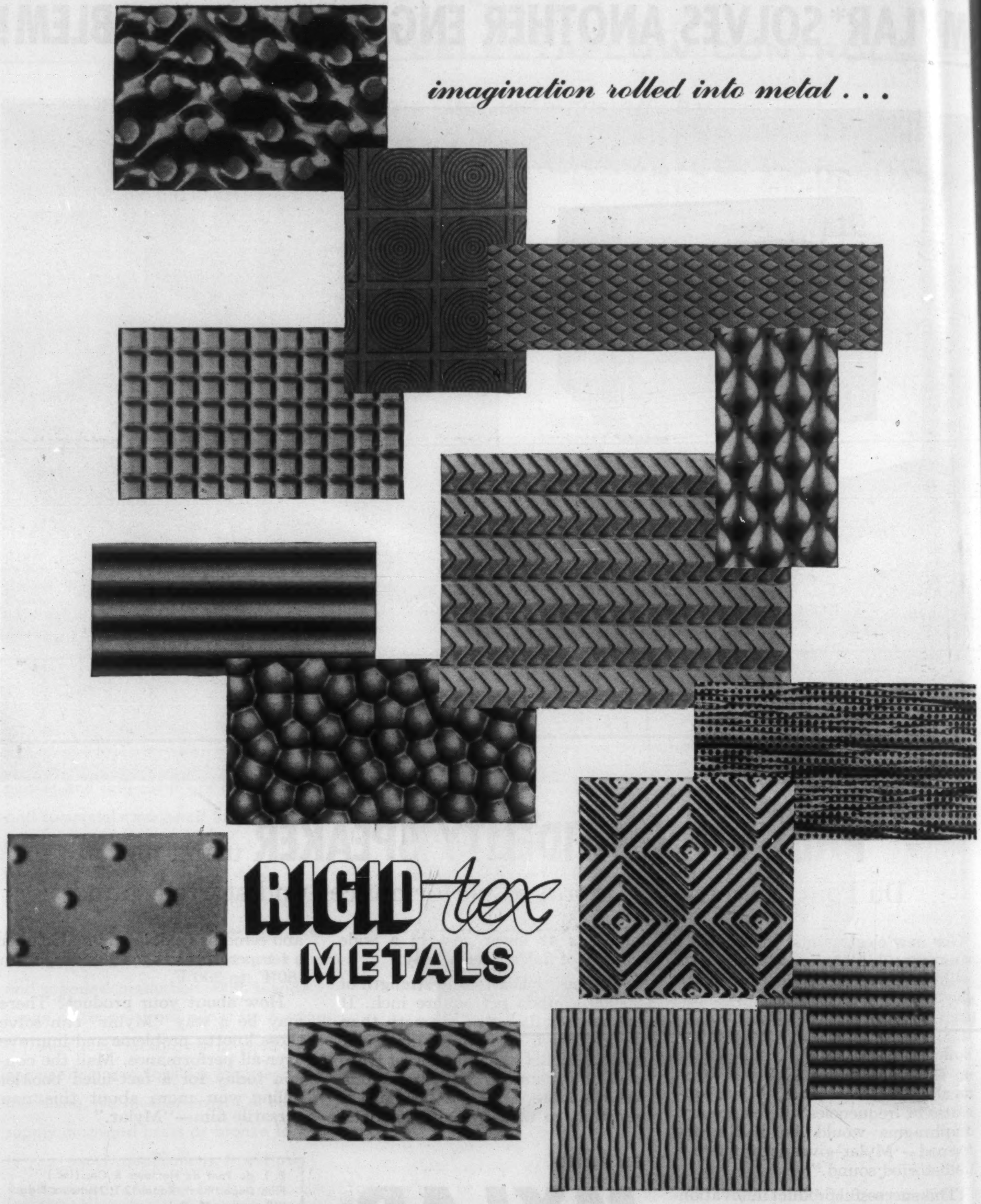

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New, high vacuum furnaces do away with the atmospheric impurities that once made such operations difficult. What's more, they can even de-gas the metals themselves.

High Vacuum Equipment Corp. (349 Lincoln St., Hingham, Mass.) makes the new units . . . turning out a wide variety of shapes and sizes for work loads of a few pounds to several tons.

Inconel* keeps retorts *gas-tight*

According to the builders, proper operation of these high vacuum furnaces calls for gas-tight retorts. They must be so nonporous that it would take 120 years for a thimbleful of air at atmospheric pressure to leak in.

They must *stay* gas-tight, too . . . and keep shape despite pressure . . . despite temperatures to 2000°F . . . despite the tremendous thermal shocks of water-spray cooling . . . despite oxidation, carburization and other forms of attack.

Inconel nickel-chromium alloy is able to handle such an assignment. It has given as much as 5000 hours in these high vacuum retorts without sign of failure.

You may be looking for an alloy like this . . . with high and lasting hot strength plus corrosion resistance. If so, look into Inconel. A new Inco booklet, "Keep Operating Costs Down When Temperatures Go Up", pictures many ways to use Inconel effectively. Write for a copy.

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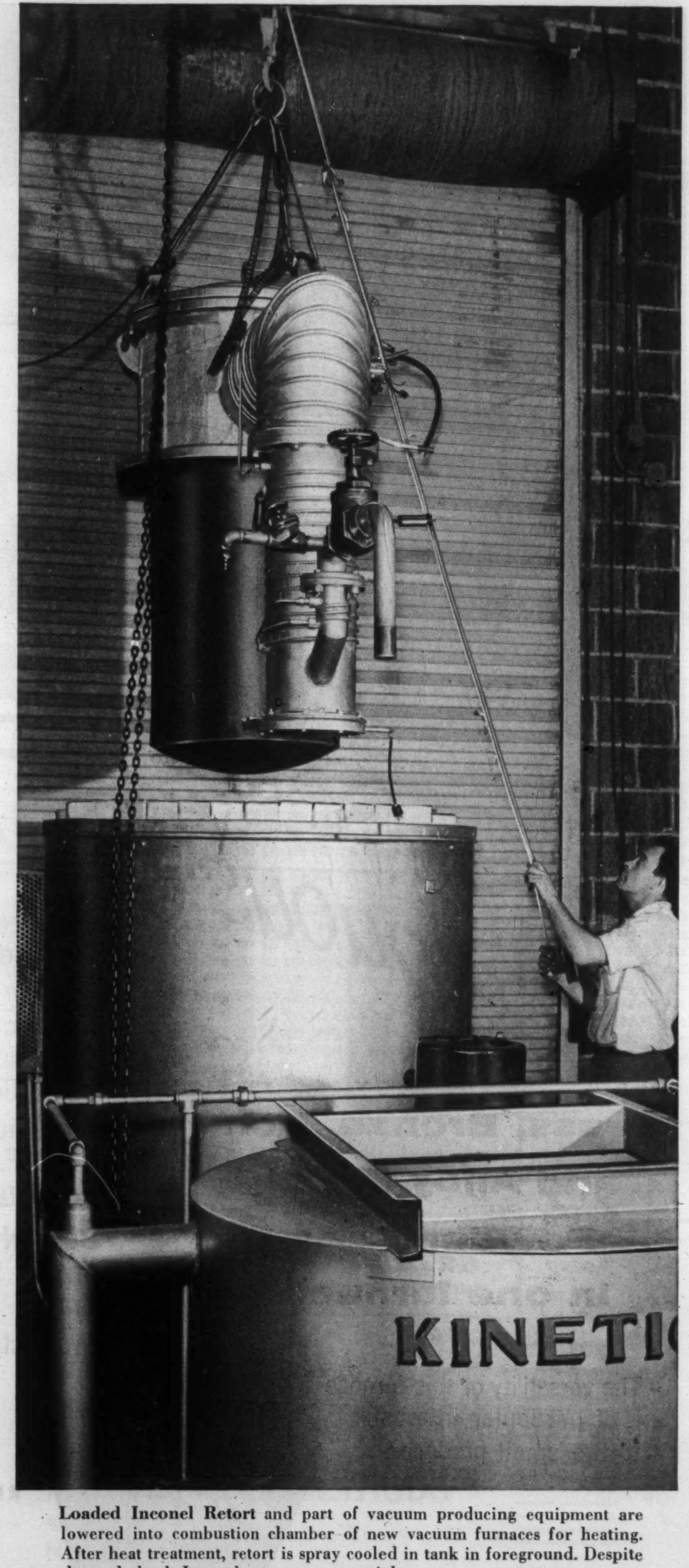

Loaded Inconel Retort and part of vacuum producing equipment are lowered into combustion chamber of new vacuum furnaces for heating. After heat treatment, retort is spray cooled in tank in foreground. Despite thermal shock Inconel retort stays gas-tight.

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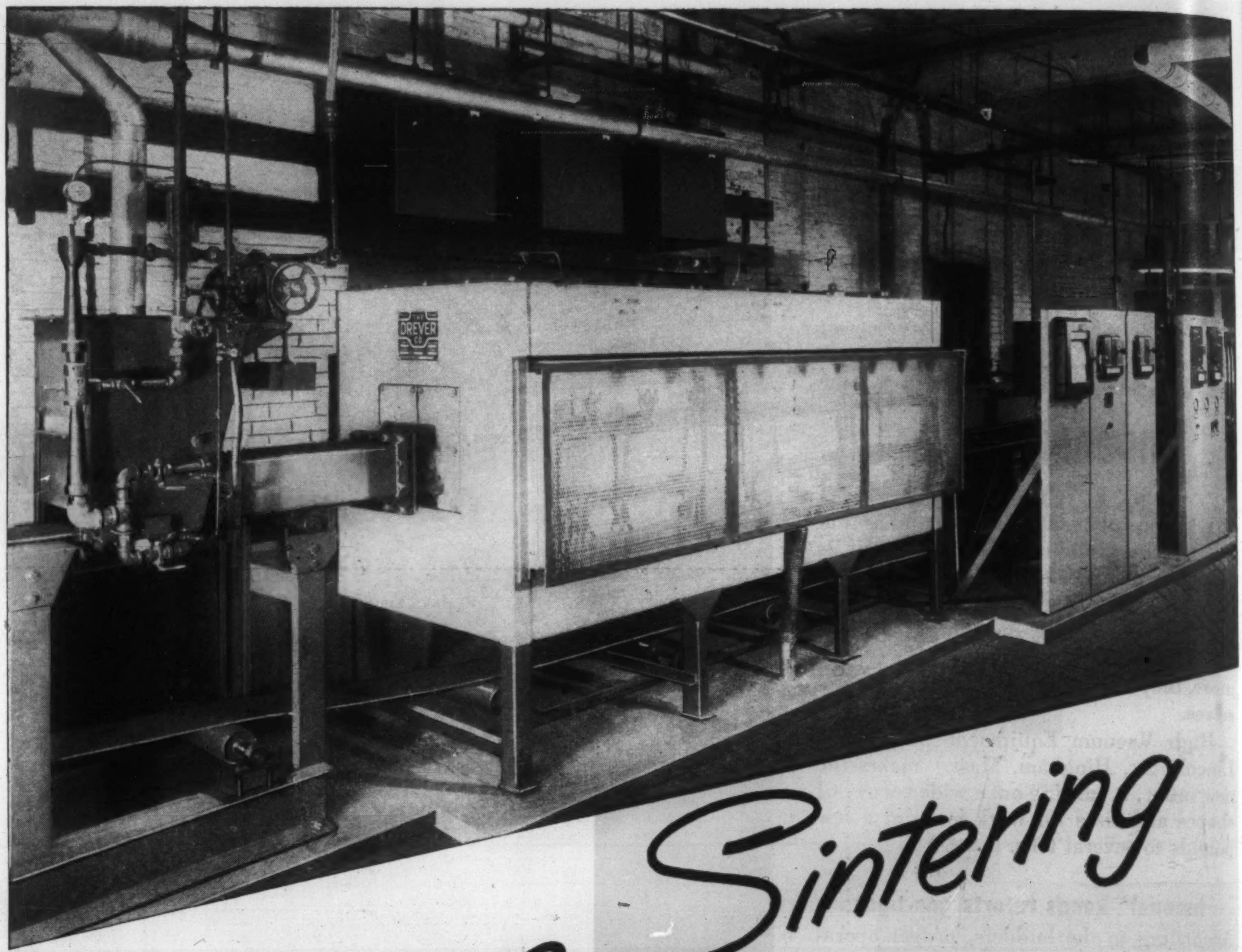

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Stainless Steel Powders. Alloy Metal Powders, Inc. Concerns sintering of high temperature alloy powders in the stainless steel group and the availability of such grades. (2)

Bismuth Alloys. Cerro De Pasco Corp., 4 pp, illus. Low melting expanding bismuth alloys for use as anchoring medium for bearings and machinery parts. (3)

Filled Epoxy Resins. Furane Plastics, Inc., 3 pp. Data sheet on Epocast 4-B and 4-B-2 filled epoxy resins including preparation, pot life and cure times and conditions, properties and applications. (4)

Silicones. General Electric Co., 12 pp, illus. A round-up of the "Silicone Story"—the forms they take, what they do, and their four basic properties illustrated. (5)

Latex Coatings. Goodyear Tire & Rubber Co., Inc., 4 pp, No. 55-244. Water dispersed polymeric compounds for coating and allied industries. Describes nitrile, vinyl, styrene and butadiene latices. (6)

Polyvinyl Chloride. H. N. Hartwell & Son, Inc., 8 pp, illus. Characteristics and properties of sheets, bar stock, pipe fittings, pipe, blocks, welding rod, valves, and fabrication of corrosion-resistant Boltaron polyvinyl chloride. (7)

Transparent Plastics. The Homalite Corp., 6 pp. Thermosetting and thermoplastics compounds for glazing. (8)

Nickel Austenitic Ductile Irons. International Nickel Co., Inc., 4 pp, illus. Paper compares properties of conventional and ductile Ni-Resist irons and summarizes present and potential industrial applications. (9)

Foamed-In-Place Resins. Isocyanate Products, Inc., 4 pp. Advantages; electrical, thermal and mechanical properties; applications; and directions for use of IPI-Isofoam, a new foamed-in-place polyisocyanate expansible resin. (10)

Nonmetallic Materials. Neff-Perkins Co., 6 pp. Bulletins describe new nonmetallic materials and developments in the field of precision molded parts, O-rings, seals, rubber to metal parts, diaphragms, gaskets, fibre and phenolic parts, and extruded parts. First group includes precision molded rubber parts, magnetic rubber, silicone-nylon diaphragms, and formed electrical insulation parts. (11)

Carbon-Graphite. U. S. Graphite Co., 64 pp, illus. Explains how Graphitar parts are made, how they are finished, their chemical properties and physical characteristics, and how to adapt design specifications to the methods of manufacturing Graphitar parts. (12)

Gas Cutting Machine. Air Reduction Sales Co., 12 pp, illus, No. 804B. Describes the 6B oxygraph gas cutting machine and its accessories. (13)

Thermosetting Molding Compounds. Barrett Div., Allied Chemical & Dye Corp., 4 pp, illus. Folder contains tabular data and discusses physical and electrical properties, chemical resistance and moldability of three Plaskon thermosetting molding compounds — urea, melamine, and alkyds. (14)

Design Handbook of Stainless Steel. Alloy Metal Wire Div., H. K. Porter Co., Inc., 38 pp, illus. Design information, applications, specifications, and charts of mechanical, chemical and physical properties for stainless steel wire, rod and strip. (15)

Brazing Alloys. Alloy Ring Service, Inc., 4 pp. Brazing alloys in the form of rings or fabrications. (16)

Molybdenum Disulfide Lubricant. Alpha Molykote Corp., 4 pp, 103A. Lists 17 types of molybdenum disulfide lubricants for extreme bearing pressure, and gives high temperature applications. Selector chart included. (17)

Stainless Fastenings. Anti-Corrosive Metal Products Co., Inc. Catalog giving net prices and actual quantities in stock for stainless steel fastenings. (42)

Investment Castings. Austenal Laboratories, Inc., 12 pp, illus. Describes Microcast process and charts representative properties of investment cast alloys. (18)

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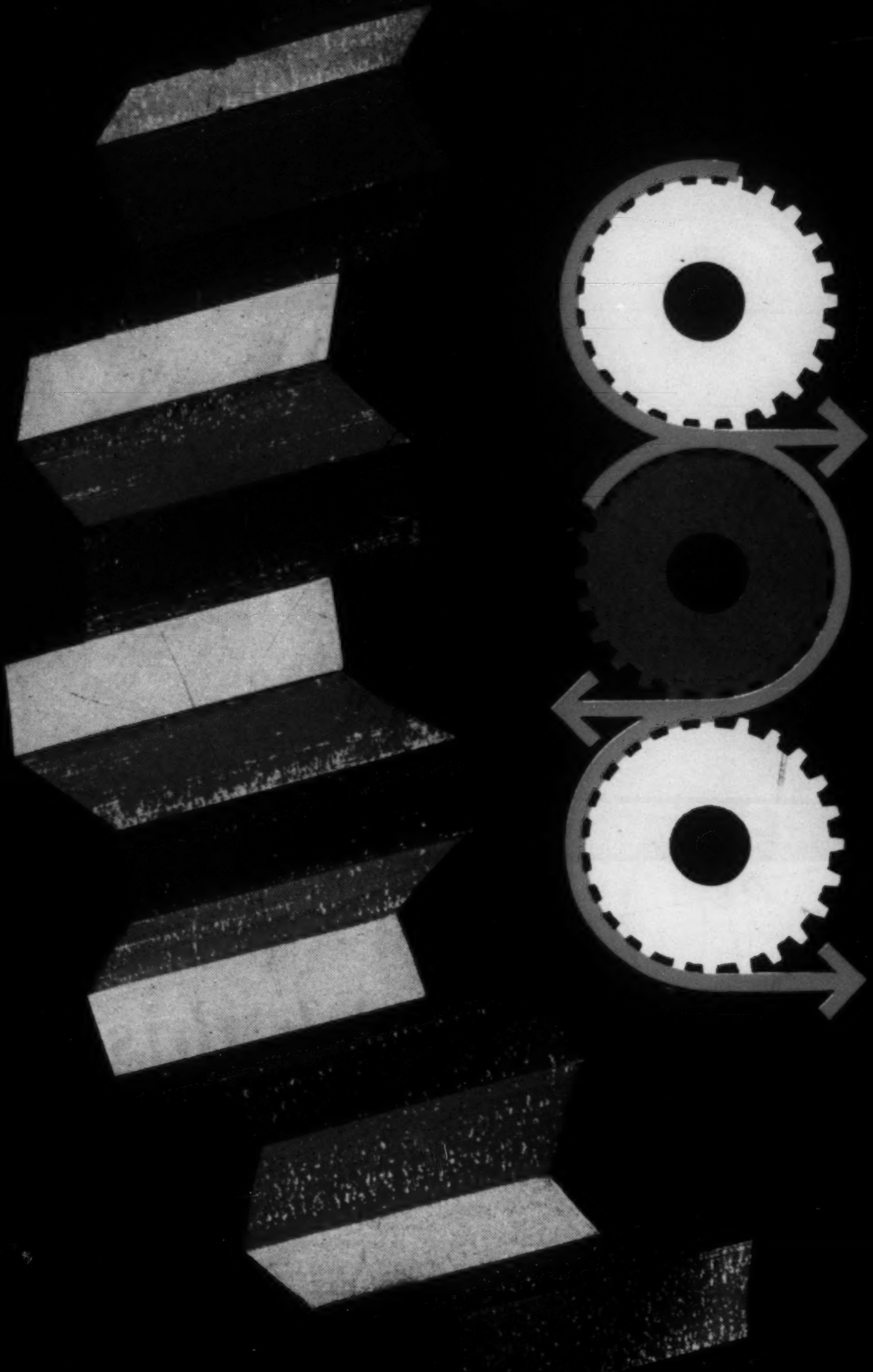
4150 steel is your best bet for heavy sections



Chromium Molybdenum Steel like AISI-SAE 4150 is the most economical way to uniform properties throughout heavy sections. For heavy duty gears — for shafts — wherever toughness and fatigue strength are important, *plentiful* 4100 Moly steels are better. We will prove it. Climax Molybdenum Company, 500 Fifth Ave., New York 36, N. Y.

AISI-SAE 4150

C 0.48/0.53	Mn 0.75/1.00	Pmax 0.040	Smax 0.040
Si 0.20/0.35	Cr 0.80/1.10	Mo 0.15/0.25	

4100 steels are your best bet

CLIMAX MOLYBDENUM

MS5-13

For more information, turn to Reader Service Card, Circle No. 362

Nuts produced by Lamson & Sessions, Cleveland, Ohio.

QUALITY YOUNGSTOWN SERVICE

Get more production with this

SCRAPLESS NUT QUALITY WIRE

Youngstown Scrapless Quality Nut Wire. The wire with the accurate sizing. The right composition. The wire that measures up to chemical and metallurgical checks for analysis. Micro-examinations, too.

Scrapless Quality Nut Wire with these qualities feeds smoothly through your machines. There is less downtime. Fewer rejects. And severe die wear is lessened.

Next time you order Scrapless Quality Nut Wire, be sure you get Youngstown. It's available in a good range of compositions, including AISI Standard as well as special re-sulphurized steels. For more information, call your nearest Youngstown District Sales Office.

THE YOUNGSTOWN SHEET AND TUBE COMPANY *Manufacturers of Carbon, Alloy and Yoloy Steel*

General Offices: Stambaugh Building - - Youngstown 1, Ohio
Plants: Youngstown, Ohio; Struthers, Ohio; Indiana Harbor, Indiana

SHEETS - STRIP - PLATES - STANDARD PIPE - LINE PIPE - OIL COUNTRY TUBULAR GOODS - CONDUIT AND EMT - MECHANICAL TUBING - COLD FINISHED BARS - HOT ROLLED BARS - BAR SHAPES - WIRE - HOT ROLLED RODS - COKE TIN PLATE - ELECTROLYTIC TIN PLATE - RAILROAD TRACK SPIKES - MINE ROOF BOLTS

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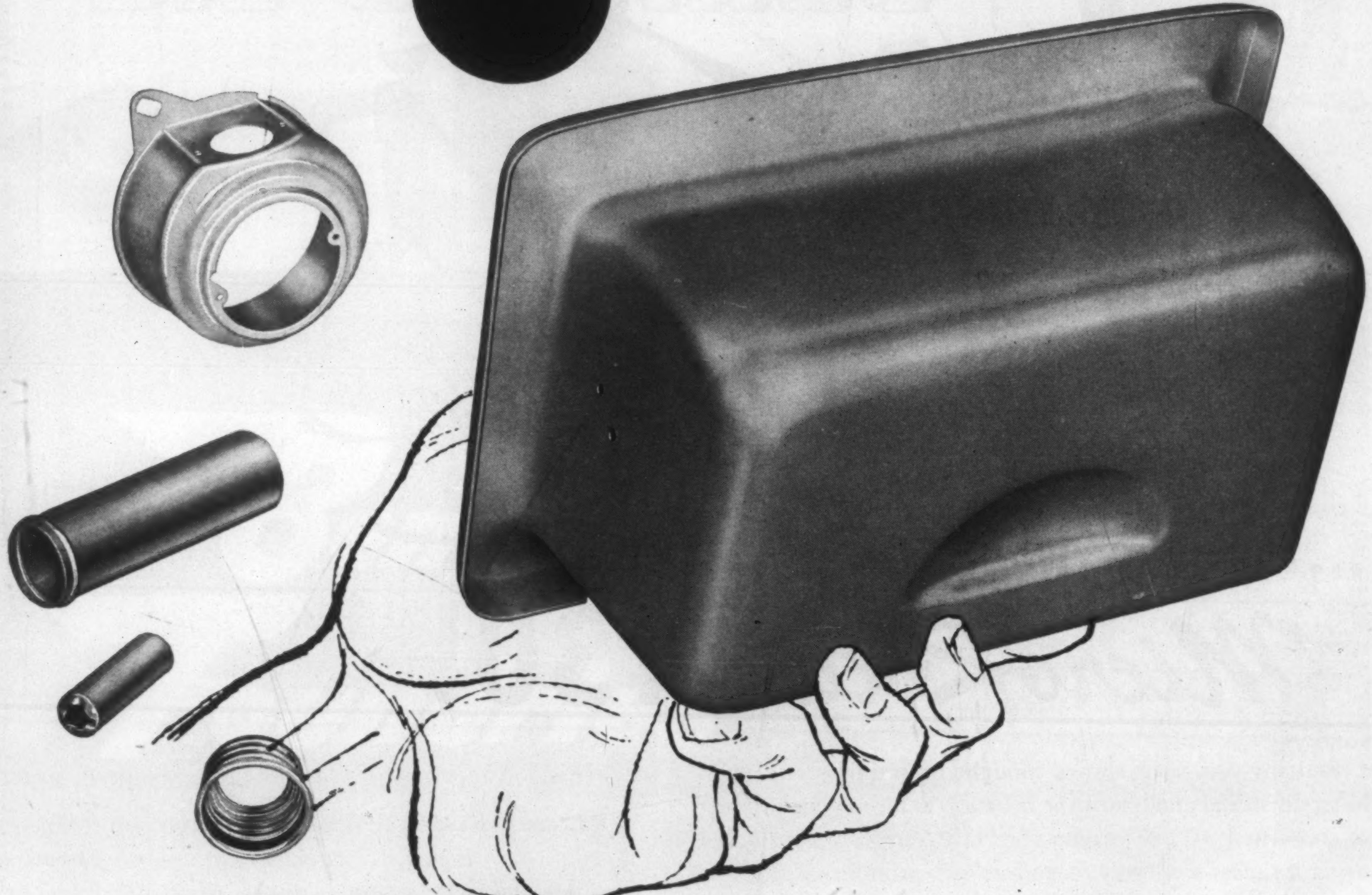
You can **sell** the difference



SCOVILL *Truspec* **ALUMINUM...**

is an exclusive development that exemplifies what we mean when we stress the salable difference in Scovill Mill Products.

Here is aluminum that sets a new standard of uniformity in meeting close specifications . . . in precision control of directional properties, temper and grain size . . . in close dimensional limits and fine finish . . . features that mark a distinct difference in commercial wrought aluminum sheet alloys.

The above photograph of typical parts demonstrates the fine fabricating qualities of Truspec . . . that make it possible for you to control "earing" and "orange peel" effect to a far greater degree than has been possible in the past.

As a result, products made from Truspec Aluminum show superior quality and finish, with fewer rejects at maximum production . . . differences any fabricator can SELL in today's market.

Scovill Manufacturing Company, Mill Products Division,
99 Mill Street, Waterbury 20, Connecticut. Phone PLaza 4-1171.

SCOVILL MILL PRODUCTS

BRASS • BRONZE • NICKEL SILVER • ALUMINUM

17SC55

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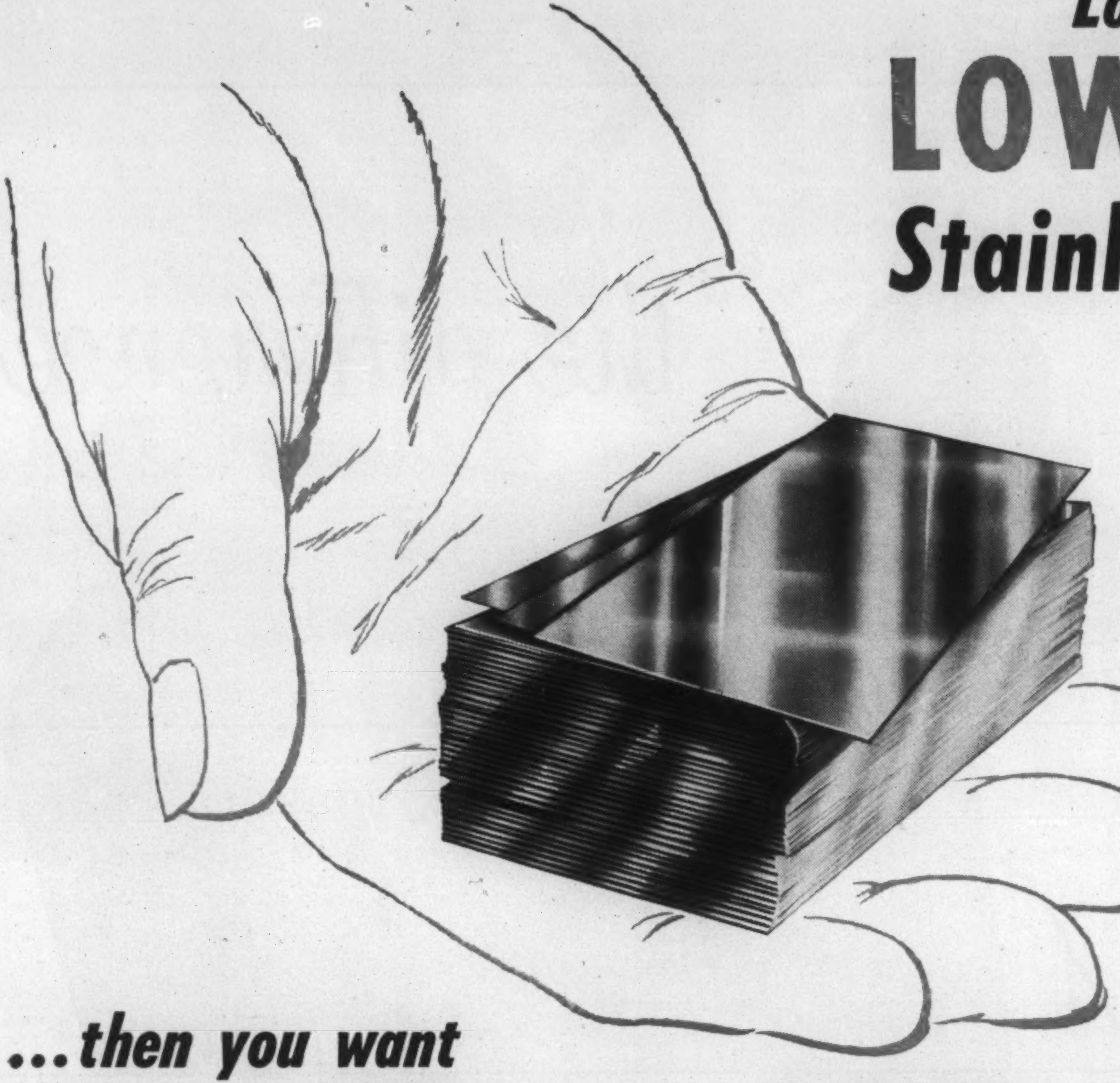
Looking For LOW COST Stainless Steel?



...then you want *MicroRold*® 430!

Perhaps you have always thought of stainless steel as a luxury material and out of the question as far as your product is concerned . . . or maybe you have seriously considered using stainless steel only to find its cost prohibitive . . .

True, some grades of stainless steel are relatively expensive, but this is because they possess higher degrees of corrosion resistance, absolutely necessary in some highly corrosive applications. This is not the complete story, however, as there are other less expensive grades of stainless having sufficient corrosion resistance without sacrificing the other desirable stainless steel qualities of beauty, strength, long life, workability and ease of maintenance.

If extreme corrosion resistance is not a factor in your product, it would be unnecessary and costly to specify a higher grade of stainless than required.

This is where MicroRold 430 enters the profit picture...

MicroRold Type 430 is a straight chromium-stainless with a nominal composition of 17% chromium. Though it is less resistant to corrosion, it retains all of the other desirable qualities of stainless and has proven very satisfactory in a wide range of mild corrosion applications.

MicroRold 430 is the least expensive of our stainless types because it does not contain nickel. This results in a 7¾c per pound difference in base price between Type 430 and Type 302, the most popular higher grade stainless. A saving of $155 per ton is possible and is of merit to cost-conscious fabricators.

Considering the price advantage, with no sacrifice in quality when applied properly, you will find MicroRold 430 a worthwhile material for your product.

Your steel distributor can help you get the most for your stainless steel dollar. He will gladly tell you the MicroRold Story.

Washington Steel
Corporation

WASHINGTON **PENNSYLVANIA**

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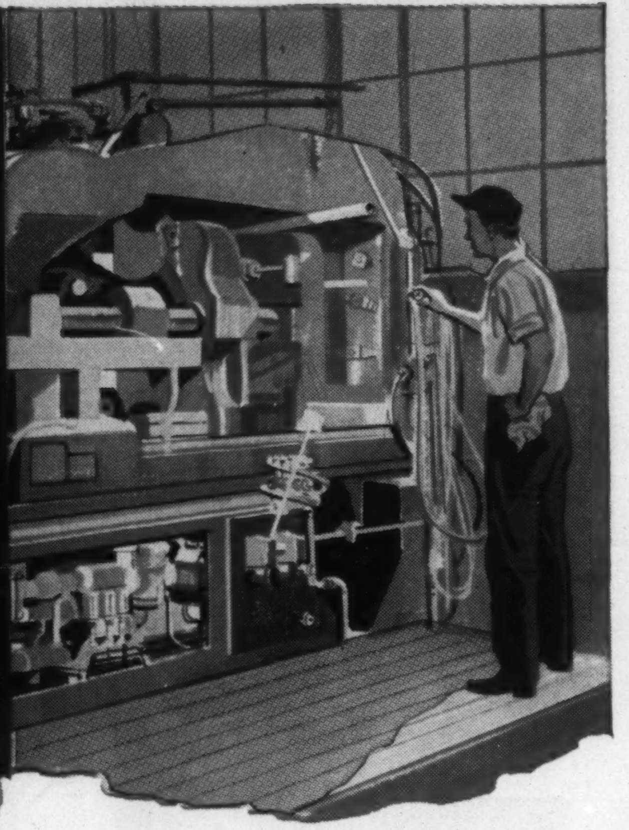
What's *your* need in DIE CASTINGS

WHATEVER YOUR NEED . . . CALL ON

Bendix Foundries

for better quality and faster service



No matter how complicated your die castings are . . . no matter what their size or shape . . . chances are that you can get better quality and faster service by dealing with us.

You save time and money with Bendix Foundries. We have a quarter century of specialized experience in the production of high-precision castings . . . of *all* magnesium and aluminum alloys.

You get what you want with Bendix Foundries. We utilize the most advanced service, methods and equipment . . . including resident government inspectors and complete metallurgical and X-ray laboratories.

If ability to produce quality castings in a wide range of sizes, shapes and varieties . . . and in production or made-to-order lots . . . interests you, write us for full details.

Check-Chart Shows Versatility of Bendix Foundries

PROCESS USED	METAL WORKED	
	ALUMINUM	MAGNESIUM
Sand	√	√
Plaster	√	√
Shell Mold	√	√
Die	√	√
Permanent Mold	√	√

BENDIX FOUNDRIES

ECLIPSE-PIONEER DIVISION Bendix AVIATION CORPORATION **TETERBORO, N. J.**

West Coast Office: 117 E. Providencia Ave., Burbank, Calif.
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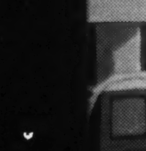

FREE . . . "Book of Facts"!

Please send me your "Book of Facts" on magnesium and aluminum castings.

Name ____________________

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State ____________________

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See what adhesives are doing today!

Setting safer paths for little feet

3M ADHESIVES

America's school buses carry especially precious cargo. That's why their designers and manufacturers place great emphasis on all details pertaining to passenger safety. Safe, non-slip flooring is one of the essentials.

To anchor floor matting to the steel floors of their school buses—and to *keep* it anchored, smooth and "trip-free"—many bus manufacturers have standardized on a 3M rubber-based adhesive. They chose it for safer floors . . . *and* because they need fast application and a quick, strong, lasting bond that will stand up under vibration, temperature changes and strong cleaning solutions.

See what adhesives can do for you . . .

3M's rubber-based adhesives provide a swift, low-cost way of joining a variety of materials. Other 3M adhesives, coatings and sealers have been created to do very specific jobs in just about every industry you can name. Like to see some more examples of what other companies are doing with 3M products? Call in your nearest 3M Field Engineer. Or, for more detailed facts on 3M products serving industry today—write to 3M, Dept. 68, 417 Piquette Avenue, Detroit 2, Mich.

ADHESIVES AND COATINGS DIVISION **MINNESOTA MINING AND MANUFACTURING COMPANY**

417 PIQUETTE AVE., DETROIT 2, MICH. • GENERAL SALES OFFICES: ST. PAUL 6, MINN. • EXPORT: 99 PARK AVE., N.Y. 16, N.Y. • CANADA: P.O. BOX 757, LONDON, ONT.

MAKERS OF "SCOTCH" BRAND PRESSURE-SENSITIVE ADHESIVE TAPES • "SCOTCH" BRAND SOUND-RECORDING TAPE • "SCOTCHLITE" BRAND REFLECTIVE SHEETINGS • "3M" ABRASIVE PAPER AND CLOTH • "3M" ADHESIVES AND COATINGS • "3M" ROOFING GRANULES • "3M" CHEMICALS

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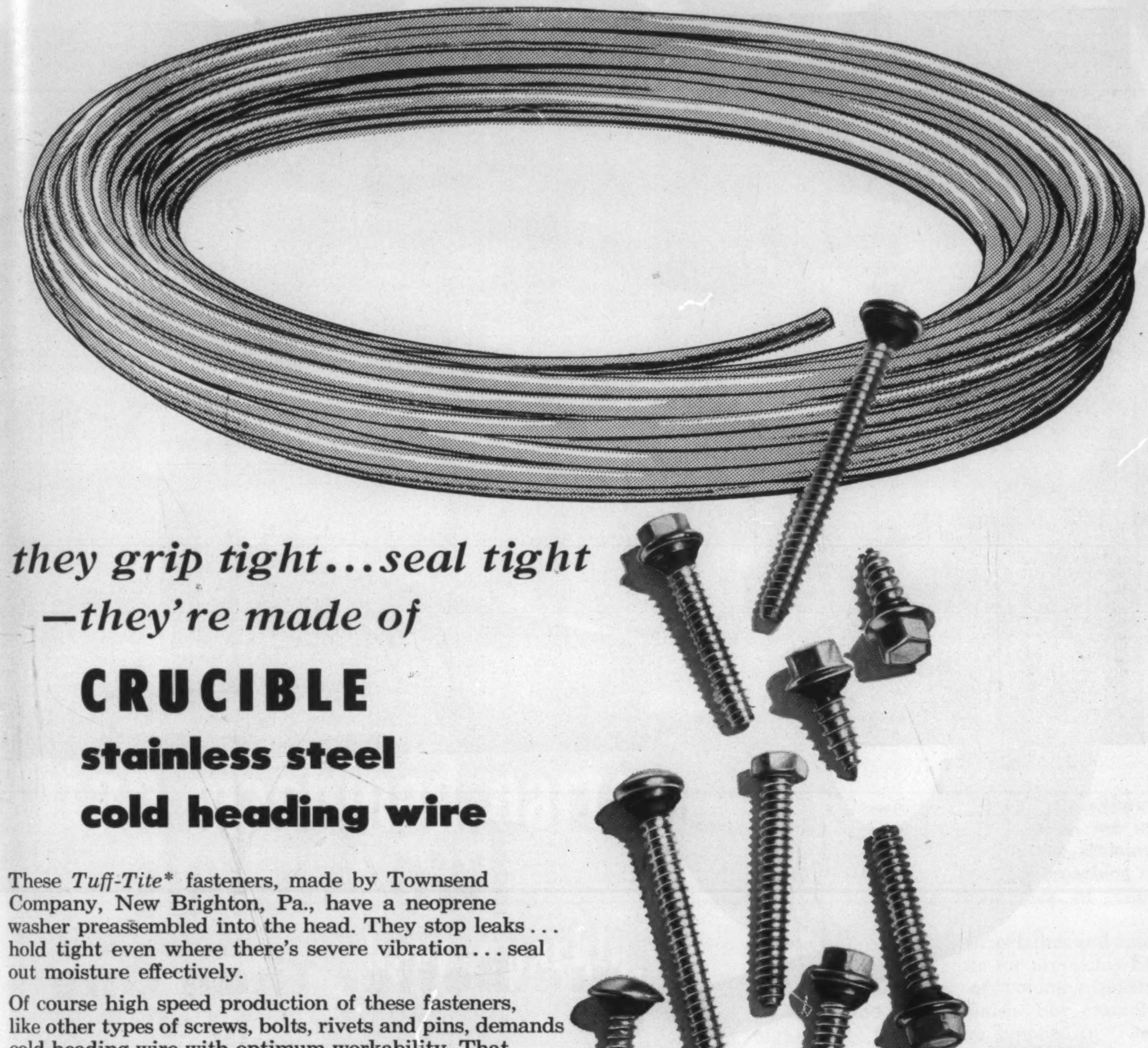


they grip tight...seal tight
—they're made of

CRUCIBLE
stainless steel
cold heading wire

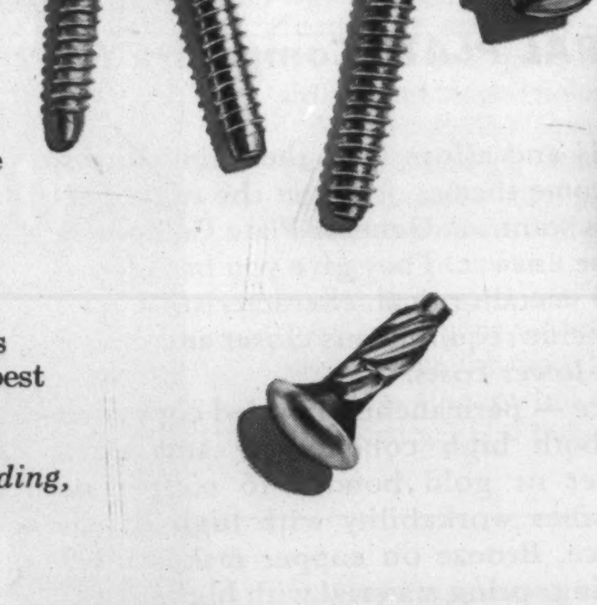
These *Tuff-Tite** fasteners, made by Townsend Company, New Brighton, Pa., have a neoprene washer preassembled into the head. They stop leaks... hold tight even where there's severe vibration... seal out moisture effectively.

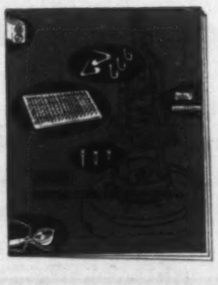
Of course high speed production of these fasteners, like other types of screws, bolts, rivets and pins, demands cold heading wire with optimum workability. That means wire that's structurally sound and metallurgically uniform... with sufficient ductility to make forming easy... and with good tensile strength.

Crucible stainless steel cold heading wire has all these qualities — *plus* exceptional corrosion-resistance. That's why Crucible Types 305 and 410 stainless are used for the new *Tuff-Tite* fasteners, as well as for many other types of fasteners.

Crucible will fill your stainless cold heading wire needs quickly and efficiently... in the grade and size that best fits your application. Talk over your production requirements with your Crucible representative soon. *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

*Trademark





Write now for your free copy of Crucible's new 32-page booklet on Rezistal stainless steel wire.

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

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Two Metals

are Better Than One

...and GENERAL PLATE Composite Metals Provide Performance plus Economy

Virgin metals and alloys have their limitations, and to overcome them . . . to get the *exact* performance you want . . . General Plate Composite Metals are the answer. They give you broadened physical and metallurgical characteristics . . . meet your specific requirements closer and do the job better, at lower costs.

For instance — permanently bonded copper to steel gives both high conductivity and extra rigidity. Silver or gold bonded to copper or bronze combines workability with high corrosion resistance. Bronze on copper makes ideal current carrying spring material with higher conductivity. Ferrous and non-ferrous combinations give you composite metals with magnetic and non-magnetic surfaces.

General Plate Composite metals in dozens of combinations eliminate many headaches . . . are the answer to corrosion, conductivity, heat dissipation, cost and many other problems.

General Plate products include . . . precious metals clad to base metals, base metals clad to base metals, thin-gauge rolling, composite contacts, buttons and rivets, *Truflex*® Thermostat Metals, *Alcuplate*®, platinum fabrication and refining, #720 Manganese Age-hardenable Alloy. Write for complete information and Catalog PR-700 today.

You can profit by using General Plate Composite Metals!

METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION
612 FOREST STREET, ATTLEBORO, MASS.

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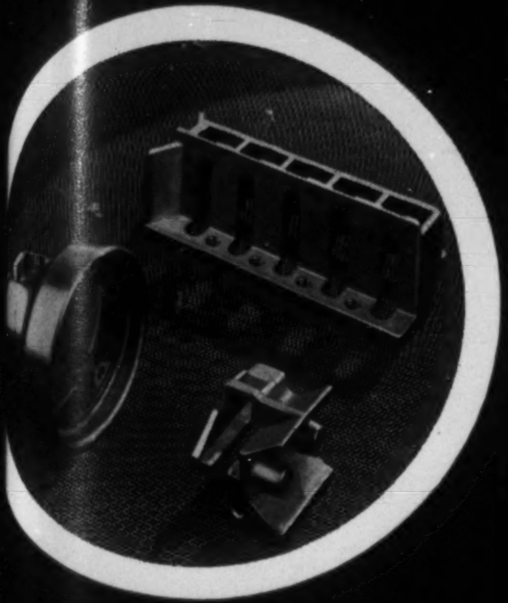
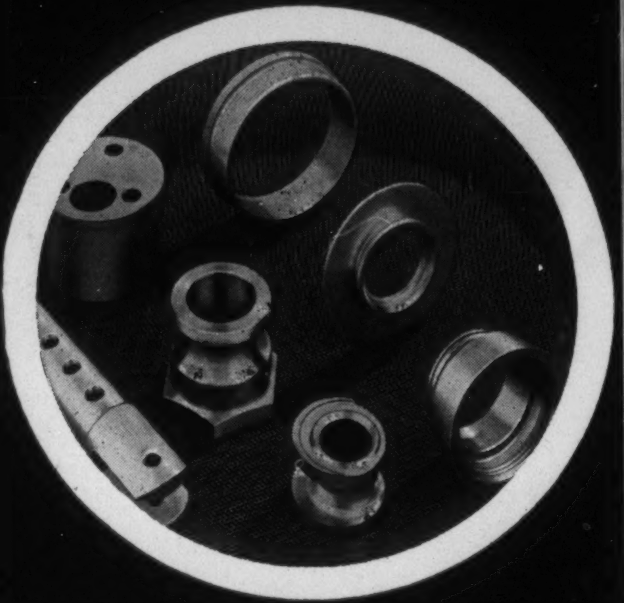


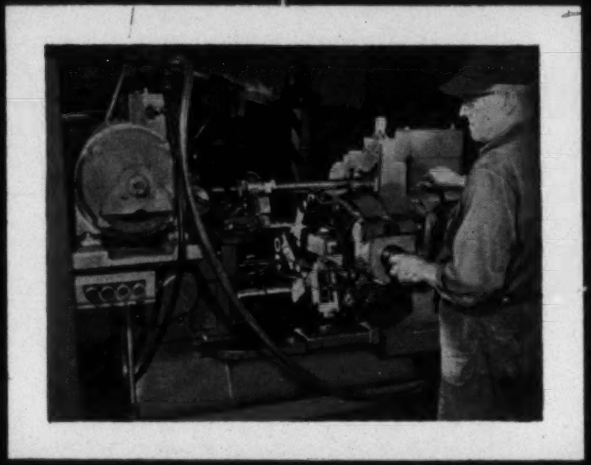
Titan brass pressure die castings

Titan brass and bronze forgings



Titan brass and aluminum hand screw machine parts

One of Titan's modern automatic chucking machines for preparing brass and aluminum forgings to customer specifications. Titan performs all types of machining operations.



Accurately machining a Titan forging on a turret lathe. Titan fabricating operations cut customers' assembly costs.

Titan machined parts

have sparkle, economy and versatility

Appeal and usefulness of brass or aluminum forgings and pressure die castings are increased greatly by multiple drilling, reaming, tapping, gang-milling, turning, broaching or knurling at the skilled hands of Titan machinists.

Equipment includes turret lathes and automatic chucking machines for producing finished machine parts of volume, quality, economy and superb finish. For example, high-quality forgings are supplied by Titan ready for assembly—already precision-broached and gang-milled with multiple-drilled and tapped holes.

When smaller quantities of fabricated parts are needed, Titan hand screw machine facilities come into play. Here, holding to closest tolerances and precision requirements is regular practice.

Let us suggest how Titan machined parts may solve your assembly problems and cut costs. Write for more information. And send for new 40-page full-color booklet "Behind the Scenes." Use the coupon below.

Titan®

METAL MANUFACTURING COMPANY

Bellefonte, Pa. Offices and Agencies in Principal Cities

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Titan Metal Manufacturing Co., Bellefonte, Pa.

Gentlemen: Please send 40-page booklet "Behind the Scenes."

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RODS • FORGINGS • DIE CASTINGS • WELDING RODS • WIRE

smaller chips mean . . .
bigger savings

Cut costs with RYCUT steels!

Three new Ryerson leaded alloys

These short, fast-breaking chips have real meaning to cost-conscious purchasing and production men. In an ever-increasing number of shops, small chips like these mean that the switch has been made to Rycut steels. They mean that tools are turning faster—that production is up as much as 200%.

The secret of Rycut's machining speed is a minute quantity of lead, finely dispersed throughout the steel. This acts as a lubricant between tool and steel. The results are revolutionizing machine shop practice:

- Up to 200% more parts can be produced per machine hour!
- Tool life is lengthened as much as 300%!
- Finish is improved!

There's a Rycut leaded alloy for every application. Use RYCUT 20 when you need a carburizing alloy; RYCUT 40 for .40 carbon alloy applications; and RYCUT 50 for .50 carbon alloy uses. Every one is a cost-cutter.

Figure how much this increased production and longer tool life would lower costs in YOUR shop—and raise your profits! Call your nearby Ryerson plant today . . . large stocks assure you of quick shipment.

NOW LEADED PLATES—Ryerson's New E-Z-Cut is the first leaded plate steel available from stock. It cuts faster, polishes easier than other free-machining plate steel.

LARGEST LEDLOY STOCKS? Ryerson has them and this leaded carbon steel is the world's fastest cutting.

RYERSON STEEL

In stock: Bars, structurals, plates, sheets, tubing, alloy and stainless steel, reinforcing bars, machinery & tools, etc.

JOSEPH T. RYERSON & SON, INC. PLANTS AT: NEW YORK • BOSTON • PHILADELPHIA • CHARLOTTE, N. C. • CINCINNATI • CLEVELAND
DETROIT • PITTSBURGH • BUFFALO • CHICAGO • MILWAUKEE • ST. LOUIS • LOS ANGELES • SAN FRANCISCO • SPOKANE • SEATTLE

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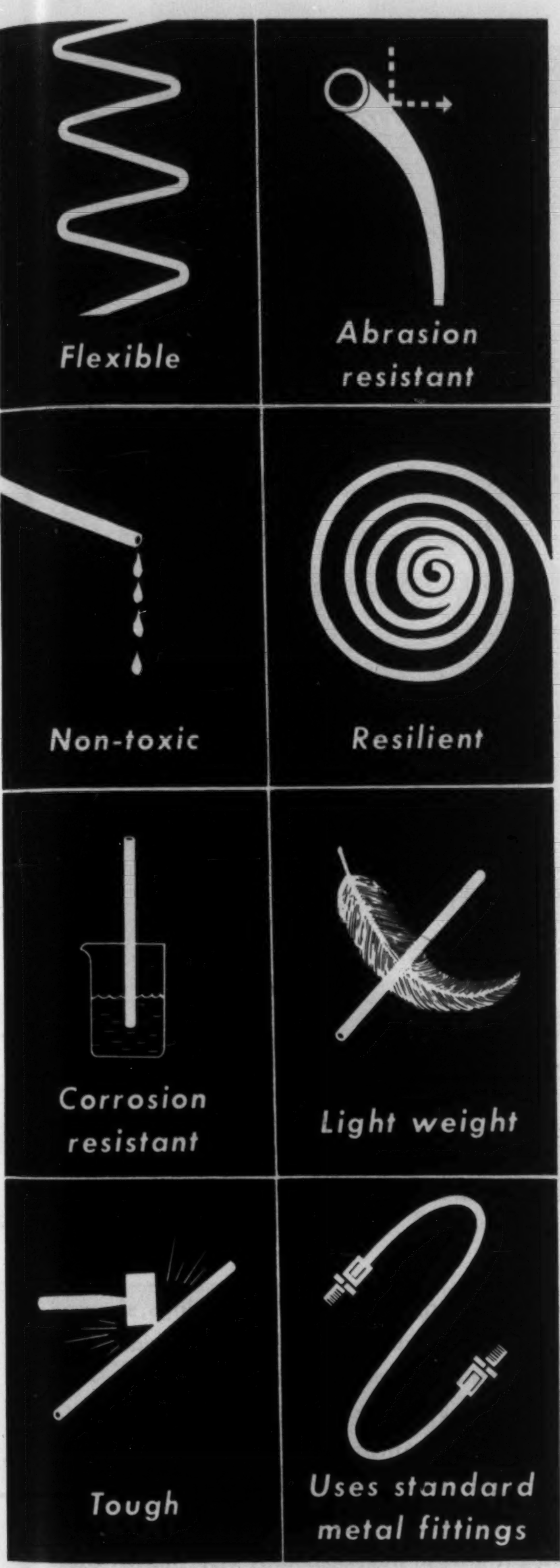

New nylaflow* tubing is all these things ...and more!

NYLAFLOW . . . the new POLYPENCO® nylon tubing . . . now permits you to get all the advantages of nylon in pressure lines for lubricants, air, fuel and oil, coolants, process streams, and hydraulic fluids.

With all its superior performance, NYLAFLOW tubing costs less in some small sizes than copper tubing. And it costs much less than flexible rubber hose.

Another thing, NYLAFLOW costs less to install. There's no pre-bending . . . no intermediate fittings . . . no flexible hose attachments. Instead, NYLAFLOW can be run in continuous lengths and connected simply by using a standard metal compression or flare fitting at each end. Because it's flexible and light weight, NYLAFLOW tubing also simplifies prefabrication of tubing assemblies.

NYLAFLOW tubing is now available in stock diameters and lengths. There are two grades: Type T with a tested bursting strength of 1,000 psi; and Type H, 2,500 psi. The tubing also is available in colors for color coding.

SEND FOR NEW
NYLAFLOW
TUBING BULLETIN

THE POLYMER CORPORATION of Penna. • Reading, Penna.

POLYMER *NYLAFLOW* TUBING
. . . nylon . . . Teflon† . . . and other non-metallic shapes

In CANADA: Polypenco, Inc., 2052 St. Catherine W., Montreal, P.Q.

†Teflon is the trademark for DuPont tetrafluoroethylene resin

*NYLAFLOW is the trademark for The Polymer Corporation's nylon tubing

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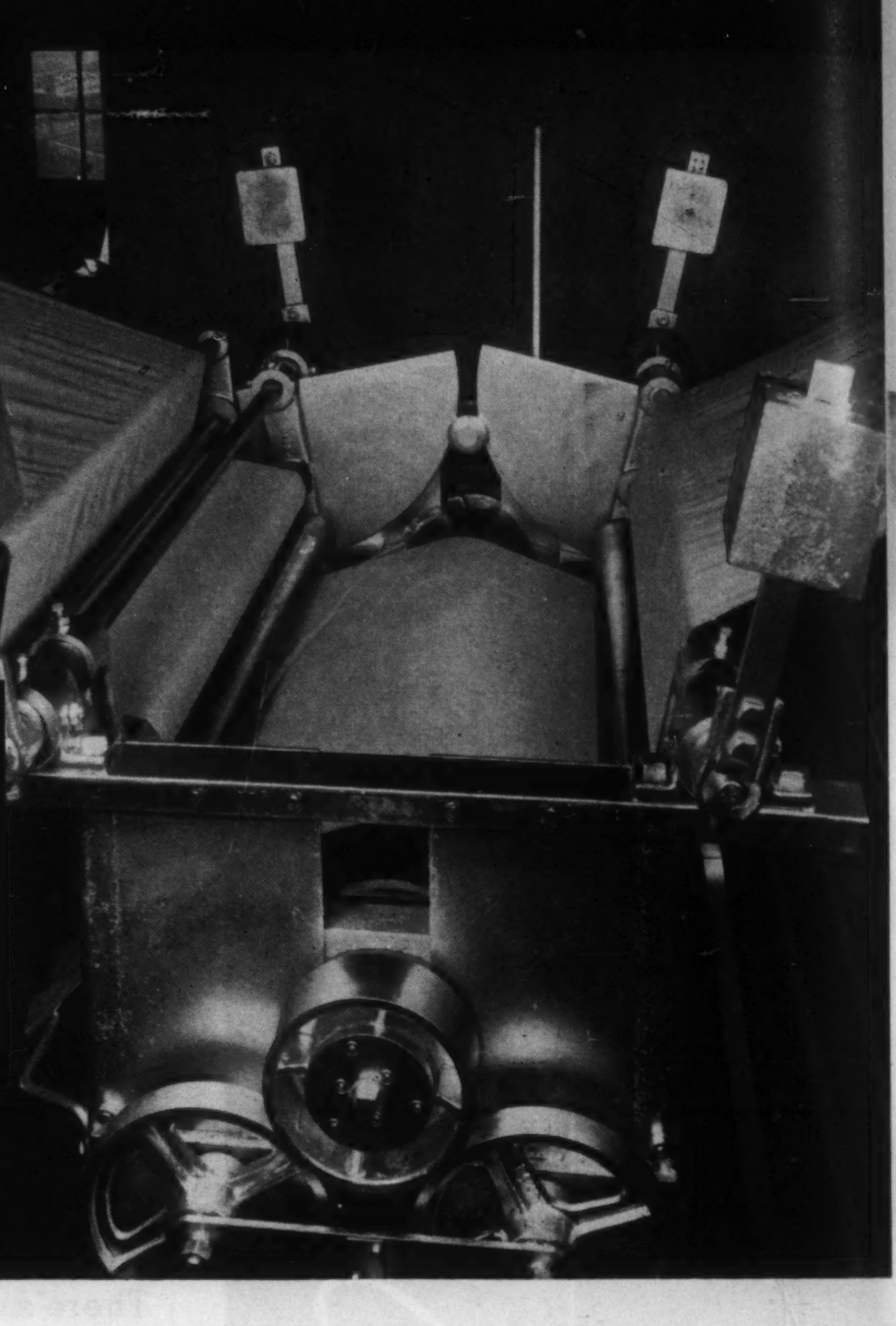
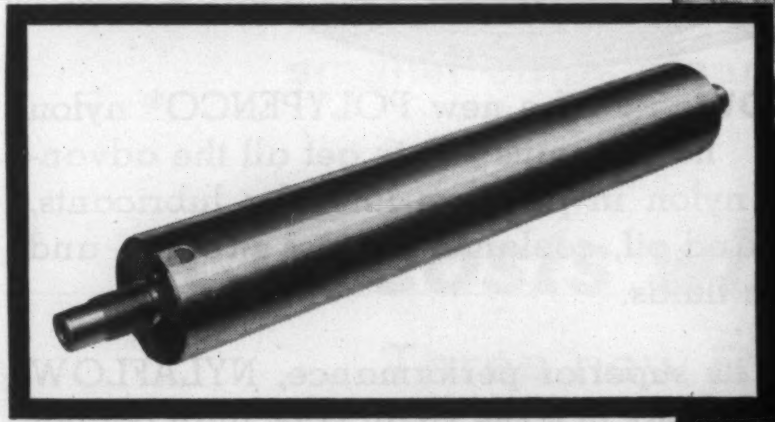
THERMALLOY* APPLICATION ENGINEERING AT WORK

It's heat treating by another name





This singe roller is made of Thermalloy to withstand the constant high temperature of furnace gases. It is part of a Rotary Plate Cloth Singeing Machine manufactured by the American Gas Furnace Co., Elizabeth, New Jersey.

They call it cloth singeing. And, normally, you wouldn't expect to find Electro-Alloys supplying high heat-resistant Thermalloy castings to the textile industry. But, wherever high heat or abrasion is a problem, you'll find Electro-Alloys coming up with answers that give more operating economy per dollar.

In this case, the singe roller, partly inserted in a furnace, is heated to 1600° F. Cloth feeds over the hot roller and is singed. The roller must endure this constant intense heat without deforming, oxidizing or otherwise contaminating the cloth.

The Electro-Alloys engineering staff, with broad experience in producing high alloy castings, showed how these rollers could be made of a special grade of Thermalloy and produced at lower cost.

Electro-Alloys cast the rollers centrifugally and delivered them completely machined, at costs below nearest competitive bidders.

Profit by this example. Electro-Alloys leadership in developing high heat-resistant Thermalloy castings and modern foundry facilities lower your heat treating costs. Our staff will work closely with you to design the casting and select the alloy best suited to your particular needs. Call our nearest representative, or write us in Elyria.

*Reg. U. S. Pat. Off.

AMERICAN
Brake Shoe
COMPANY

ELECTRO-ALLOYS DIVISION

6001 TAYLOR ST., ELYRIA, OHIO

Sales offices in: Los Angeles, Oakland, Chicago, Detroit, New York,
Cleveland, Philadelphia, Pittsburgh

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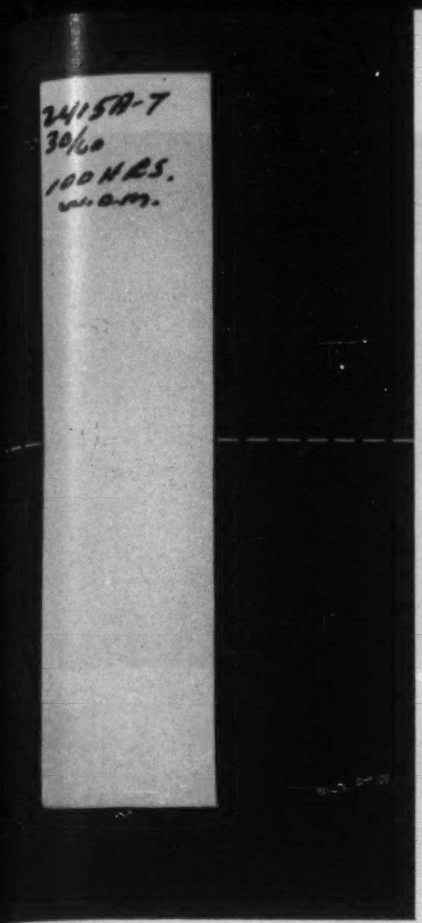
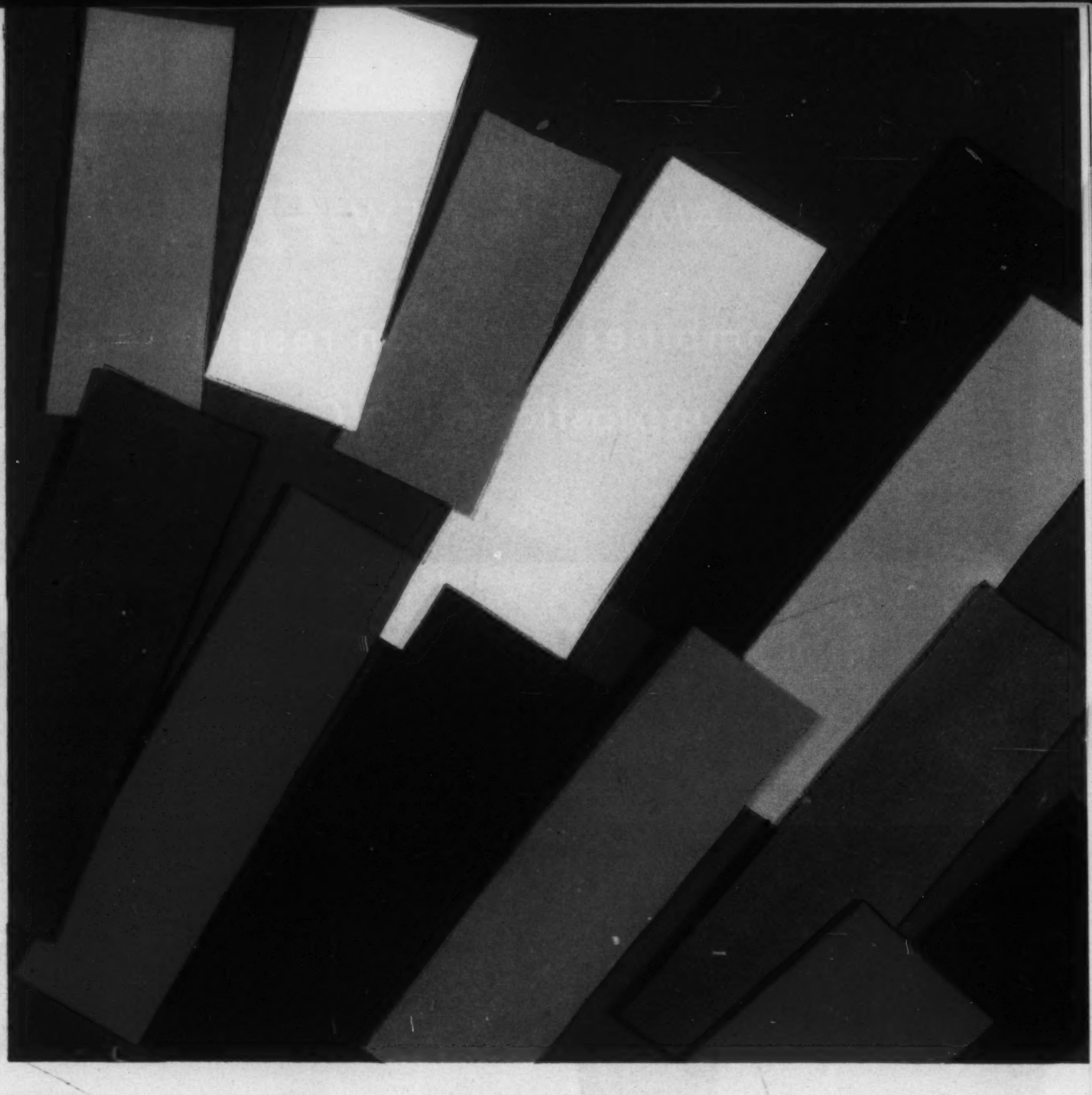


OVE: Lower half of this white HYPALON mpound was exposed for 100 hours to an celerated weathering test. Note that the posed half shows no perceptible change whiteness from the unexposed half.

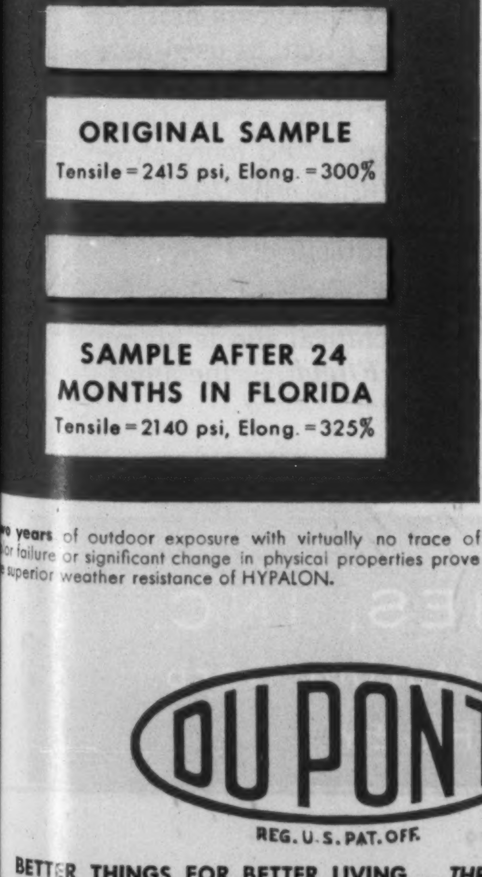
GHT: Sample strips of HYPALON showing illiant colors possible. HYPALON can be mpounded in an unlimited range of light-able colors.



NEW CHEMICAL RUBBER

DU PONT HYPALON®

as excellent color stability through an unlimited color range


ORIGINAL SAMPLE
Tensile = 2415 psi, Elong. = 300%
SAMPLE AFTER 24 MONTHS IN FLORIDA
Tensile = 2140 psi, Elong. = 325%

o years of outdoor exposure with virtually no trace of or failure or significant change in physical properties prove superior weather resistance of HYPALON.

Now . . . lasting color in an elastomer, even under the most severe exposure conditions! HYPALON, Du Pont's new chemical rubber, brings a bright new world of color to design. HYPALON products can be specified in an unlimited color range. Colors start bright . . . *stay* bright.

Color stability is not the only advantage offered by HYPALON. Its ability to withstand a wide range of *extreme service conditions* makes it ideal for products where your design calls for maximum durability.

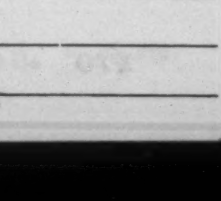
HYPALON has exceptional heat resistance. It can successfully operate at temperatures in the range of 250° to 350°F.

HYPALON has excellent chemical resistance. It resists deterioration from strong oxidizing chemicals better than any other elastomer. It is also highly resistant to most other chemicals.

HYPALON is completely resistant to ozone attack. HYPALON has never been known to fail from exposure to ozone . . . under any conditions of concentration or service.

HYPALON resists oil, grease, abrasion, flame and flex cracking—a line-up of properties that mean extra-long service, no matter what conditions your product encounters. Almost all manufacturers who make rubber products can produce products of HYPALON. Current uses include hose; coatings for fabric, rubber, wood and metal; gaskets; tank linings; and molded and extruded parts. Be sure you send in coupon below to get full details about HYPALON.

SEND FOR FREE BOOKLET. Here's your introduction to HYPALON—its properties and uses. Learn how *you* can use products made of this new chemical rubber to improve your design.



DU PONT
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BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

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E. I. du Pont de Nemours & Co. (Inc.)
Elastomers Division, MM-12
Wilmington 98, Delaware

Please send me your folder on the properties and uses of HYPALON.

*Name*________________ *Position*________

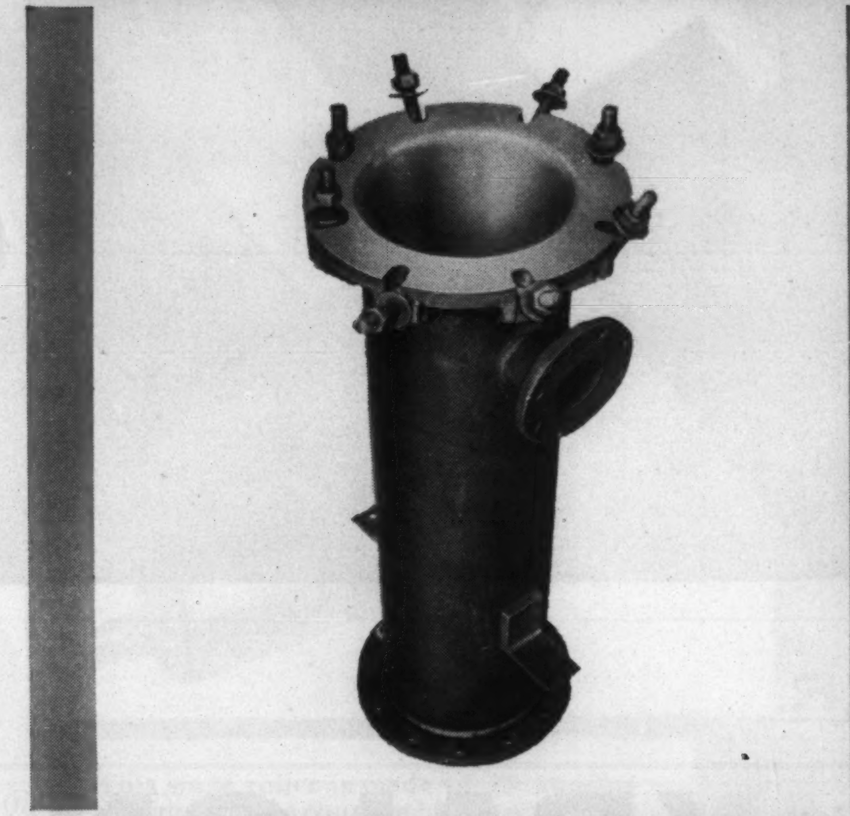
*Firm*________________

*Address*________________

City *State*

AMAZING NEW *FLIGID*® LINING

combines corrosion resistance and strength of unplasticized PVC with easy application of flexible PVC



Pressure filter body lined with Fligid withstands powerful chlorine dioxide bleach, at pressures to 50 pounds per square inch. Inside diameter of filter body is 14 inches, length is 5 feet.

Exposed Face of Fligid is unplasticized PVC. Resists corrosives, withstands tough wear. No plasticizer to contaminate reagents. Inner Face is resilient, flexible PVC, easily applied to any size, shape, structure.

NOW . . . line any steel, wood, or concrete structure with *unplasticized* Polyvinyl Chloride! New Vyflex® *Fligid* gives you the wide range chemical resistance, the superior physical toughness that modern corrosion protection demands. Yet it's easily applied to the most complicated process equipment by simple adhesive bonding techniques with no curing.

HOW? Because *Fligid* is actually *two* materials. Flexible, resilient, easily applied L-10 PVC lining material on one face . . . inert, unplasticized F-92 structural PVC on the other! You get the advantages of both — the disadvantages of neither.

But that's not all. Because *Fligid* is used as a lining and not a self-supporting material, it takes temperatures as high as 190 F in many solutions. The outer face of *Fligid* is harder and more abrasion resistant than *any other lining material*, often eliminating the necessity for masonry sheathing used to provide mechanical protection.

WRITE NOW FOR FREE DATA! Get your copy of the just published technical sheets giving complete facts on new Vyflex *Fligid* . . . the amazing *flexible-rigid* laminate.

®

KAYKOR INDUSTRIES, INC.
Division of Kaye-Tex Manufacturing Corp.
YARDVILLE, NEW JERSEY

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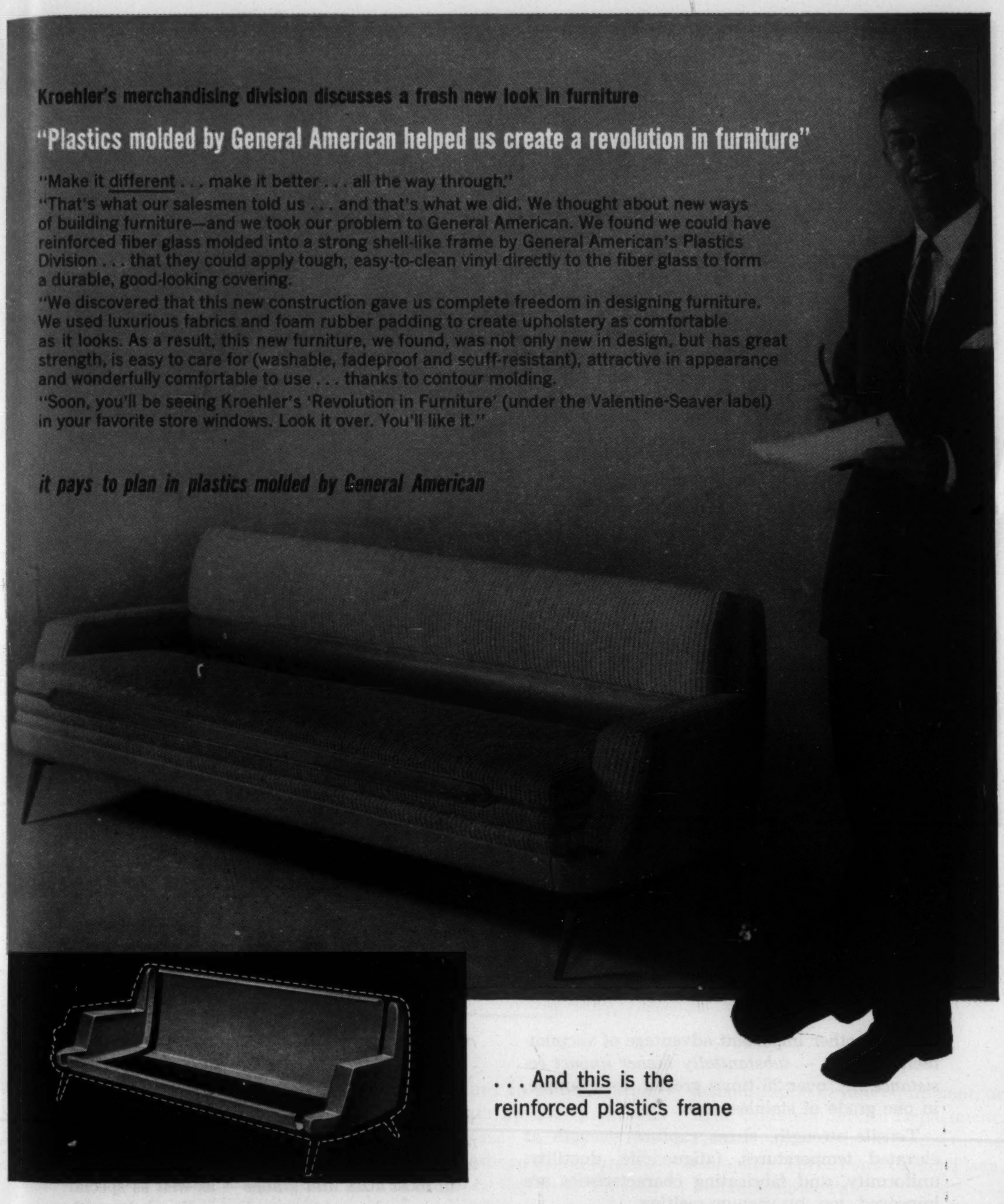


Kroehler's merchandising division discusses a fresh new look in furniture

"Plastics molded by General American helped us create a revolution in furniture"

"Make it different . . . make it better . . . all the way through."

"That's what our salesmen told us . . . and that's what we did. We thought about new ways of building furniture—and we took our problem to General American. We found we could have reinforced fiber glass molded into a strong shell-like frame by General American's Plastics Division . . . that they could apply tough, easy-to-clean vinyl directly to the fiber glass to form a durable, good-looking covering.

"We discovered that this new construction gave us complete freedom in designing furniture. We used luxurious fabrics and foam rubber padding to create upholstery as comfortable as it looks. As a result, this new furniture, we found, was not only new in design, but has great strength, is easy to care for (washable, fadeproof and scuff-resistant), attractive in appearance and wonderfully comfortable to use . . . thanks to contour molding.

"Soon, you'll be seeing Kroehler's 'Revolution in Furniture' (under the Valentine-Seaver label) in your favorite store windows. Look it over. You'll like it."

it pays to plan in plastics molded by General American

. . . And this is the
reinforced plastics frame

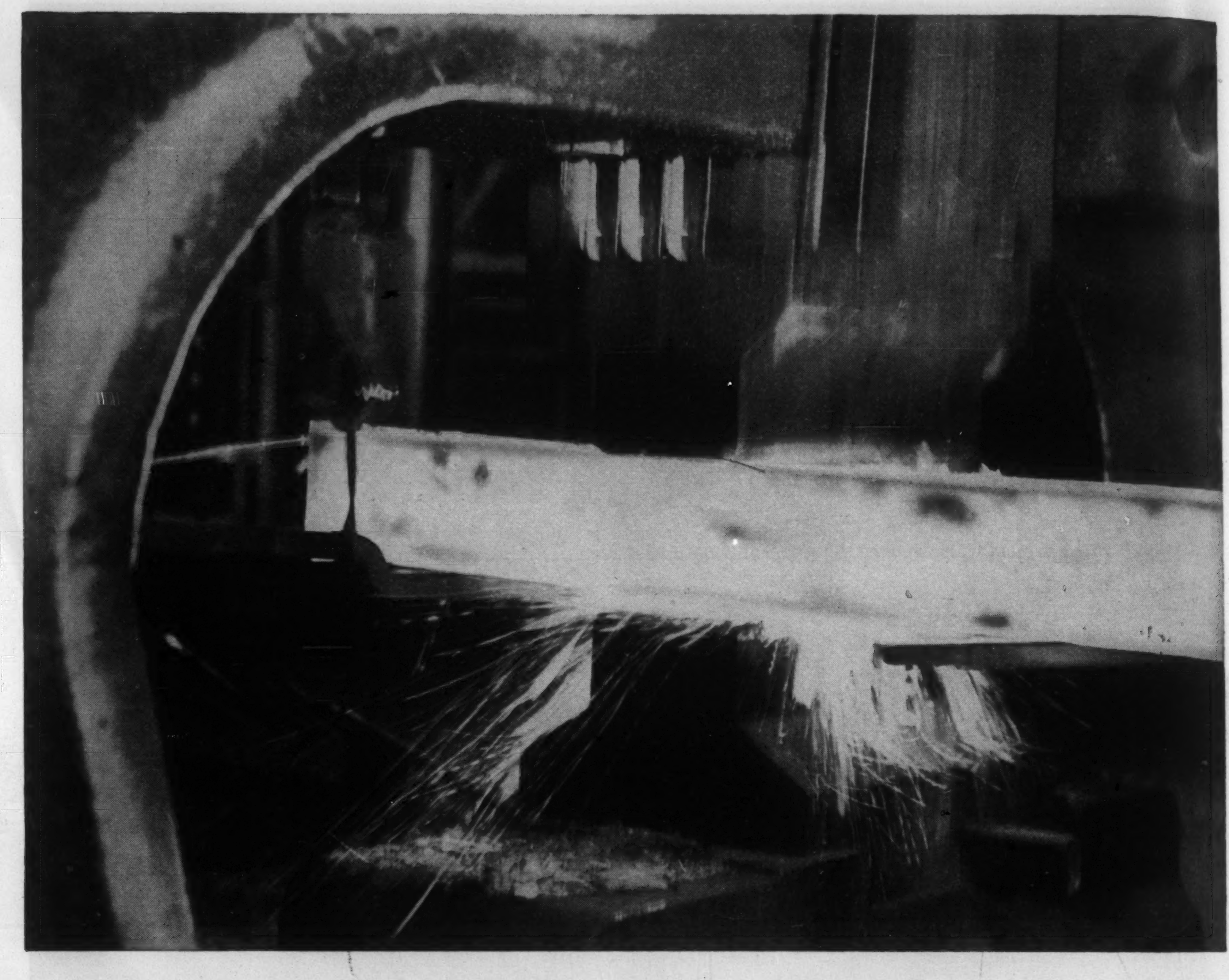
PLASTICS DIVISION GENERAL AMERICAN TRADE MARK

PLASTICS DIVISION

GENERAL AMERICAN TRANSPORTATION CORPORATION
135 South La Salle Street • Chicago 90, Illinois

Facilities unmatched anywhere: injection, compression, extruding, vacuum forming, reinforced plastics, painting and assembling

For more information, turn to Reader Service Card, Circle No. 437



From Vacuum Melting—improved alloys with exceptional properties

...higher* IMPACT RESISTANCE, *for example

Here's another important advantage of vacuum-melted alloys — *substantially higher impact resistance* . . . over 25 times greater, for example, in one grade of stainless steel.

Tensile strength, stress rupture strength at elevated temperatures, fatigue life, ductility, uniformity, and fabricating characteristics are improved, too, by vacuum-melting.

Here's why . . . *Vacuum-melting literally sucks gaseous impurities from the molten metal . . . removes inclusions and gases that limit the performance of conventional air-melted alloys. That means purer metals that are stronger, tougher . . . closer to their theoretical limits of properties.*

Vacuum Metals Corporation, pioneer in development and leading producer of vacuum-melted metals, now can promptly supply them in tool, high-speed, stainless, and alloy steels — in most sizes and grades — as well as special ferrous and nonferrous alloys. For help with metal problems that vacuum-melted alloys might solve, please write us, describing them in as much detail as possible. *Vacuum Metals Corporation, P. O. Box 977, Syracuse 1, N. Y.*

VMC

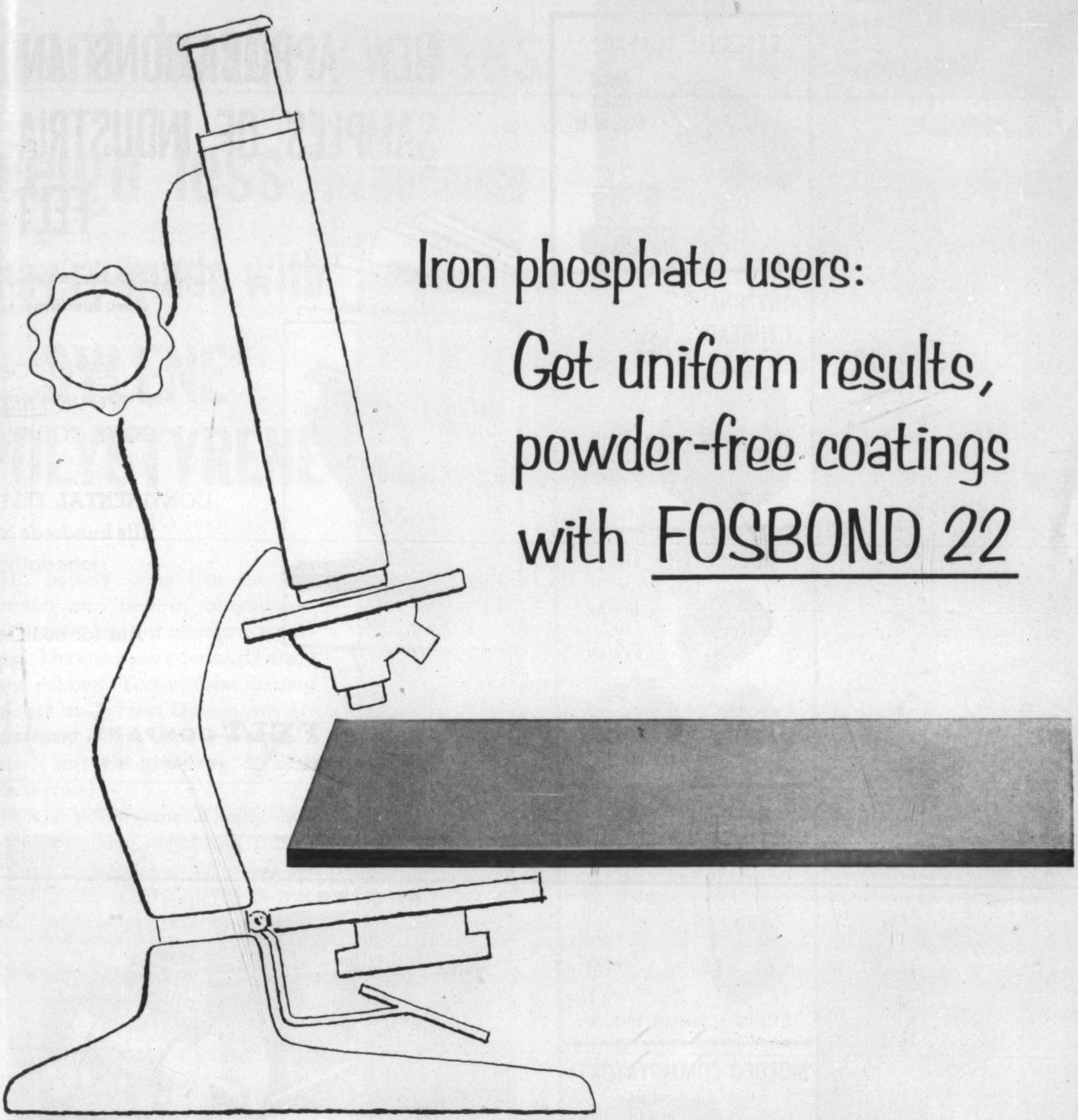
VACUUM METALS CORPORATION

Jointly owned by Crucible Steel Company of America and National Research Corporation

For more information, turn to Reader Service Card, Circle No. 412

Iron phosphate users:

Get uniform results, powder-free coatings with FOSBOND 22



Here's a truly dependable iron phosphate coating! Fosbond® 22 assures uniform, trouble-free phosphate protection of metal parts, cuts your finishing rejects to the bone. The balanced composition of Fosbond 22 prevents the highs and lows of ordinary phosphate films, and its superior cleaning power often lets you clean and coat in one spray bath.

Shipped as a dry powder in a non-returnable drum, Fosbond 22 simplifies your storage and processing all down the line. In addition, long, economical bath life and improved corrosion-resistance under organic finishes help Fosbond 22 pay for itself in re-charge savings and lowered reject rate.

TRY IT IN YOUR CYCLE. See how this inexpensive, easily-controlled phosphate system cuts cleaning and coating costs. Where iron phosphate coating is indicated, you just can't match the simple Fosbond 22 process. Ask your Pennsalt representative for a demonstration in your equipment, or write Customer Service Department, Pennsylvania Salt Manufacturing Company, Three Penn Center Plaza, Philadelphia 2, Pa.

Pennsalt Chemicals

A BETTER START FOR YOUR FINISH

For more information, turn to Reader Service Card, Circle No. 378

For more information, turn to Reader Service Card, Circle No. 487

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many types and sizes

supplied from stock

to help motor makers

build better motors

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Metal Insert Molded in

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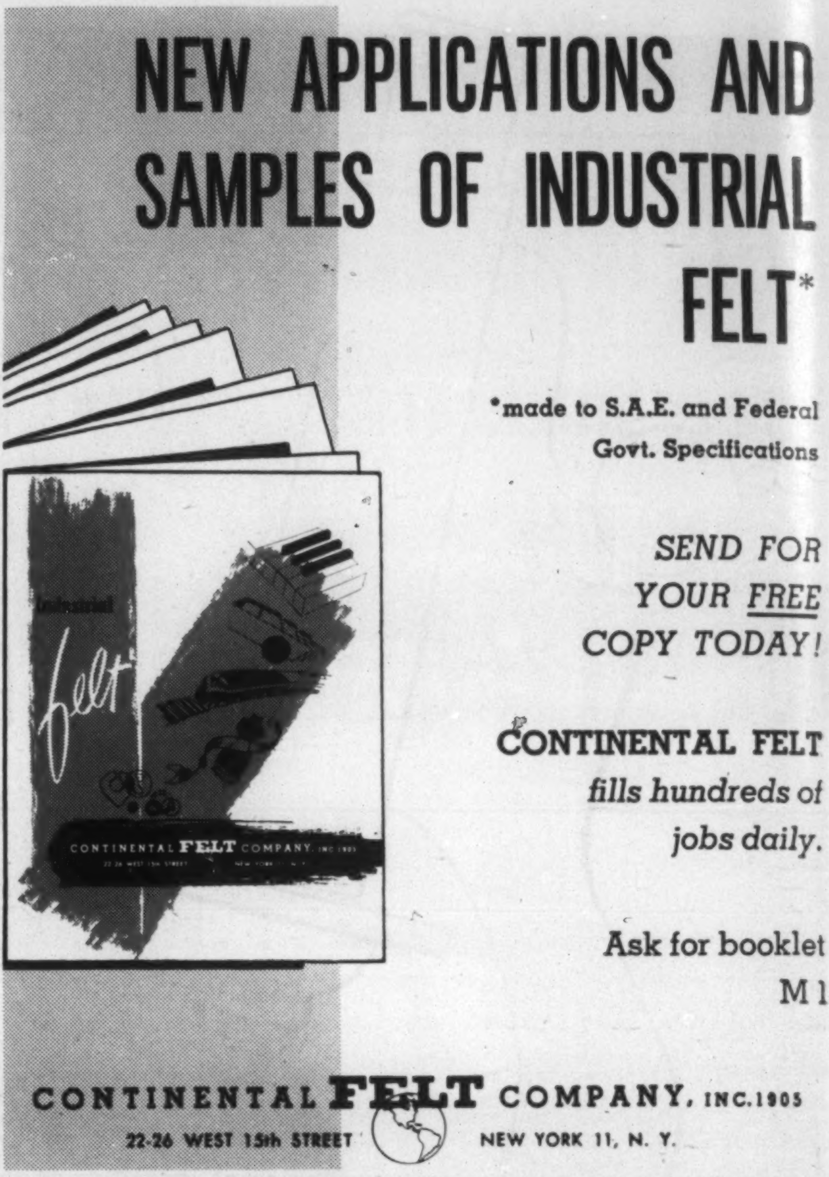

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NU-CUP | CONVENTIONAL

the shaft tells the story!

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And This Is The Reason:

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We specialize in Solving Puzzling Set Screw Problems

For more information, turn to Reader Service Card, Circle No. 468

Giant battery cases weigh less...because they're made with

DYLENE* POLYSTYRENE

Manufacturer: The Electric Storage Battery Company, Exide Industrial Division, Philadelphia, Pa. This 13¼" x 14½" x 19½" battery case, molded by the Mack Molding Company, Arlington, Vt., is believed to be the largest single mold shot ever made.

Big battery cases like the one pictured are used in communication centers and for emergency purposes. The cases were formerly made from rubber. Today these battery cases are made from Dylene polystyrene. They weigh approximately 15 pounds and will give long, dependable service.

Dylene polystyrene is being used to replace glass, metal and rubber in many industrial applications. By choosing the right type of Dylene plastic you can get such qualities as high impact resistance, low water absorption, dimensional stability, and high heat distortion resistance. Parts made from this lightweight plastic can be molded in any shape you need . . . *at low cost.*

Koppers engineers will give you technical assistance in selecting the proper Dylene polystyrene to improve your product or reduce production costs. Write to us for more information.

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Looking for a TOUGHER STEEL?

Unusually tough, even at sub-zero temperatures, Lukens "T-1" steel can reduce equipment costs.

Failure from abrasion or from impact can happen to the steel in your equipment, too. Here's the answer—the tougher steel you've been looking for. Lukens "T-1" steel has excellent resistance to the combination of wear and impact, is tough enough to withstand unusual stresses and pressures as well as shock at either sub-zero or high temperatures, thus lowering maintenance costs and lengthening equipment life.

Because of its high yield strength (over 90,000 psi) this new, all-purpose steel offers lighter weight and reduced thickness in comparison to heavier, thicker plates of carbon steel, thereby reducing material, construction and shipping costs. Engineers and designers can take advantage of Lukens "T-1" steel's many superior properties, such as its ready weldability and excellent wear characteristics, which will pay off in design freedom and increased equipment efficiency. And Lukens' range of steel plate sizes—including the widest and heaviest plates available anywhere—makes possible additional savings through the use of wider plates that require fewer welded seams.

The latest addition to Lukens' complete line of carbon, alloy and clad steels, this quenched and tempered alloy plate steel's unusual combination of properties suits it especially to application in pressure vessels, bridges, shipbuilding, construction machinery and general industrial equipment. On problems of design, selection, application and fabricating techniques, Lukens offers full technical assistance. If you would like further information on Lukens "T-1" steel, write today. Address: Manager, Marketing Service, 776 Lukens Building, Lukens Steel Company, Coatesville, Pennsylvania.

LUKENS

"T-1" STEEL

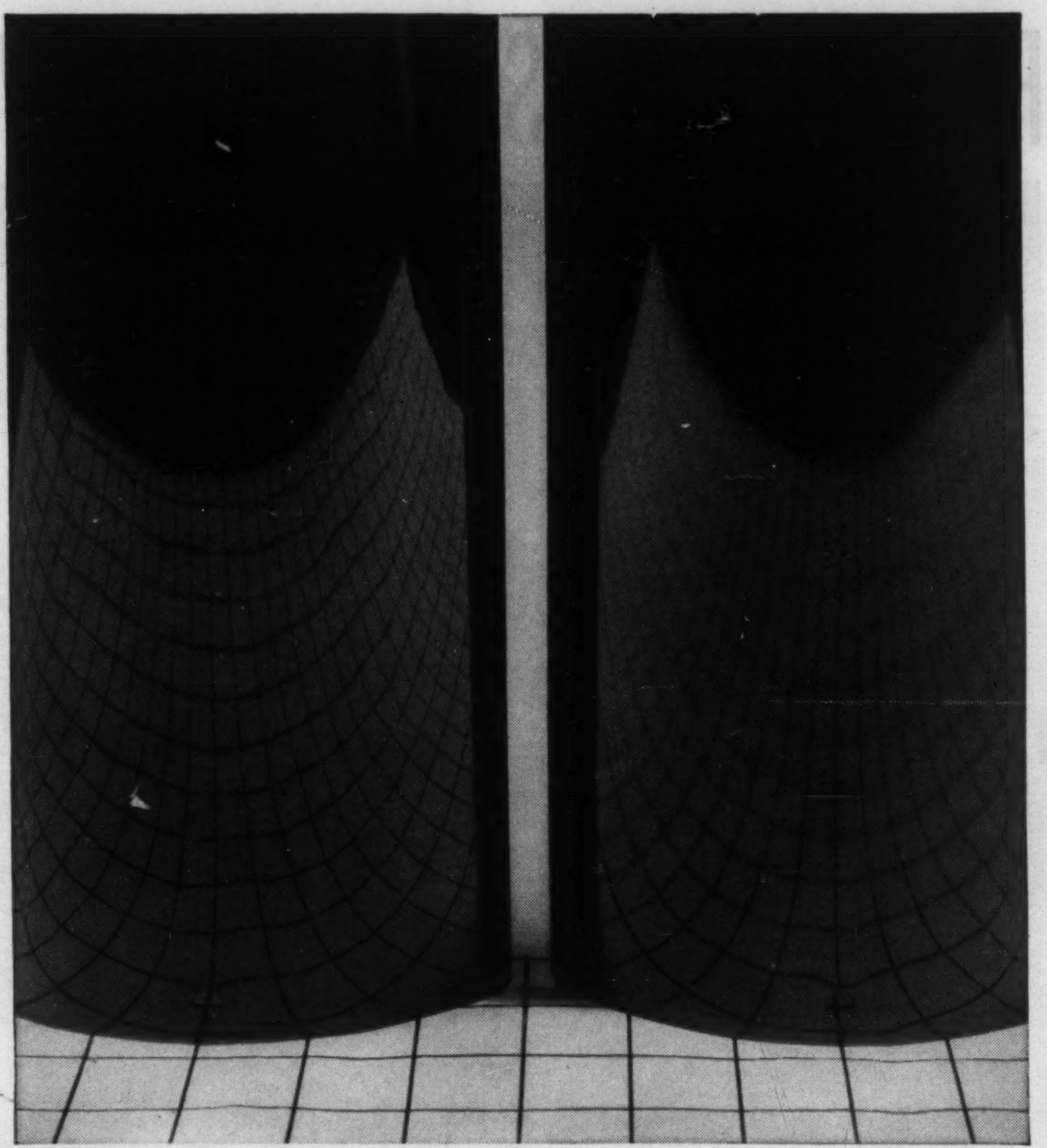
To get the new, 28-page book on Lukens "T-1" steel, ask for Bulletin 781.

THE NEWEST IN A COMPLETE LINE OF ALLOY STEELS

LUKENS STEEL COMPANY, COATESVILLE, PENNSYLVANIA

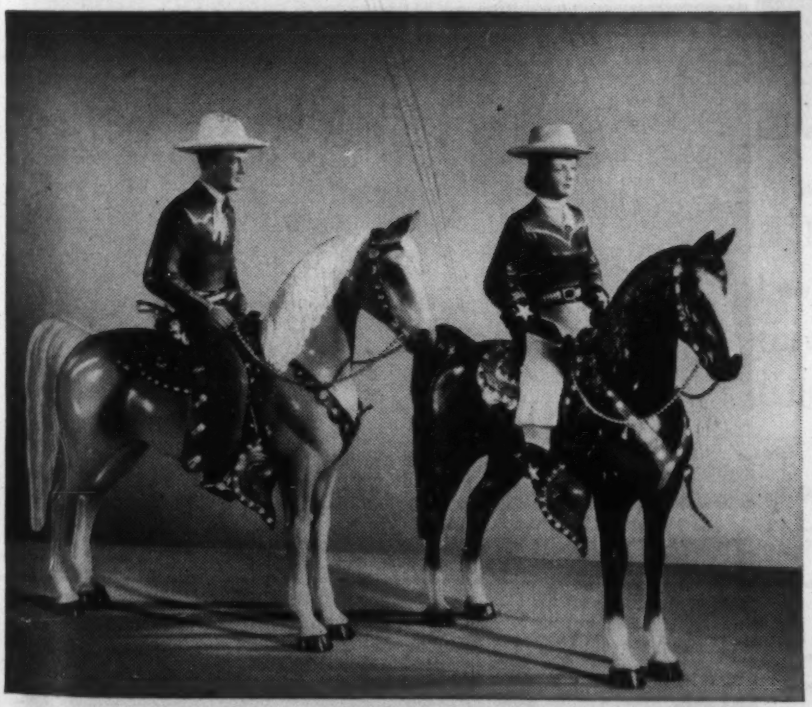
For more information, turn to Reader Service Card, Circle No. 374

Developments in Lacquer of Interest to You

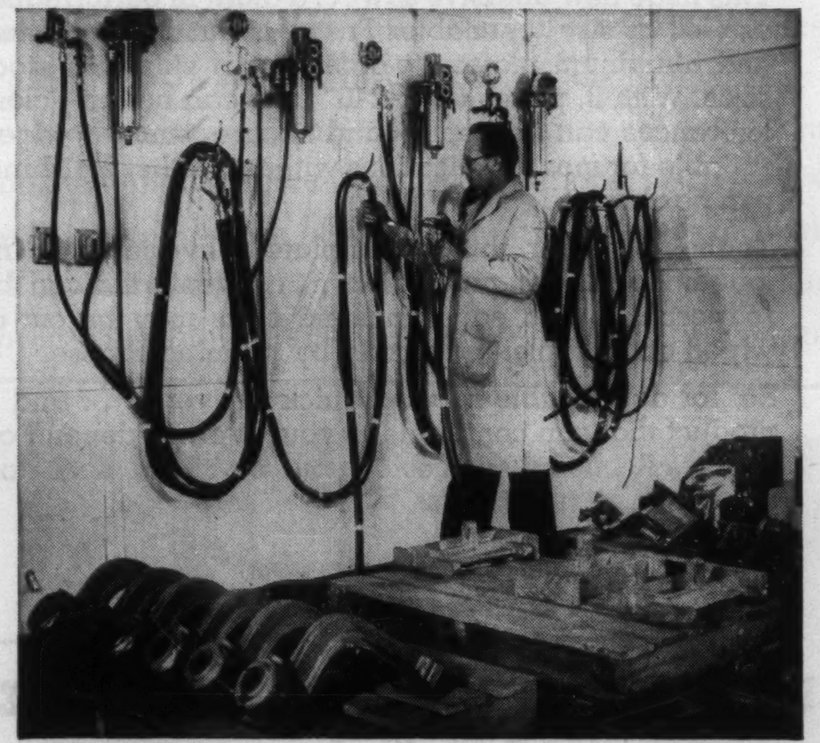


HIGHER GLOSS—There's a new "no-sanding" approach to better gloss on metals. A combination fine-pigment and resin formulation is used for primer and top coat and applied by the "high-low, hot spray" method. The clearer reflection in the left-hand panel demonstrates the effectiveness of this finishing method. ➡

RUST ROUTED—Castings which must be temporarily stored or shipped long distances before finished machining is done are protected against rust quickly and economically by a single coat of lacquer. ⬇



⬆**COLORFUL PLAYTHINGS**—Lacquer for plastics makes it possible to achieve multi-colored effects on single molded units. Lacquer not only speeds production with its quick drying, but cuts costs by permitting the use of more economical plastic materials.



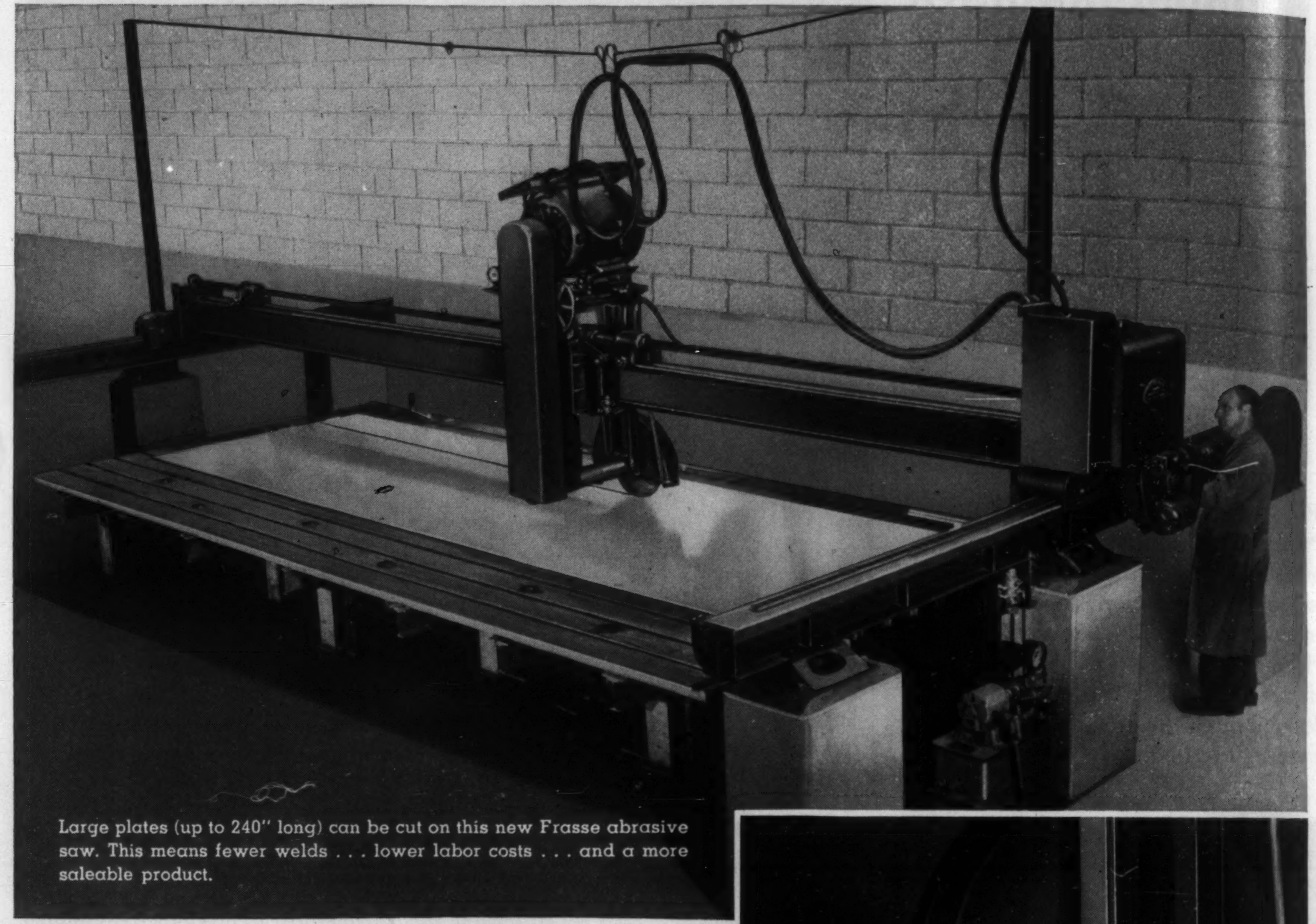
Hercules does not make lacquer but supplies the cellulosics and Parlon® (chlorinated rubber) on which lacquers are based. Further technical information on these and other developments in lacquer-type coatings is available by writing to Hercules.

Cellulose Products Department
HERCULES POWDER COMPANY
INCORPORATED
996 Market Street, Wilmington 99, Del.

CL55-5

For more information, turn to Reader Service Card, Circle No. 416

FRASSE INSTALLS HUGE ABRASIVE PLATE SAW...



Large plates (up to 240" long) can be cut on this new Frasse abrasive saw. This means fewer welds . . . lower labor costs . . . and a more saleable product.

This huge new abrasive saw . . . a giant in performance as well as size . . . enables Frasse to cut stainless steel and aluminum plates "to-order" from standard stock sizes. With it, plates up to 240" long can be cut—close tolerances can be kept — and square, smooth edges, suitable for most applications without further finishing, can be obtained.

To the fabricator, this means plate deliveries need no longer bottleneck production . . . inventories can be reduced . . . and edge finishing costs may be cut or wiped out completely, simply by phoning Frasse.

So, for dependable service, quick delivery . . . and a product that can contribute to your profit — depend on Frasse. A *choice* source for your stainless steel and aluminum requirements.

Call FRASSE 1st

For STAINLESS STEEL and ALUMINUM PLATES

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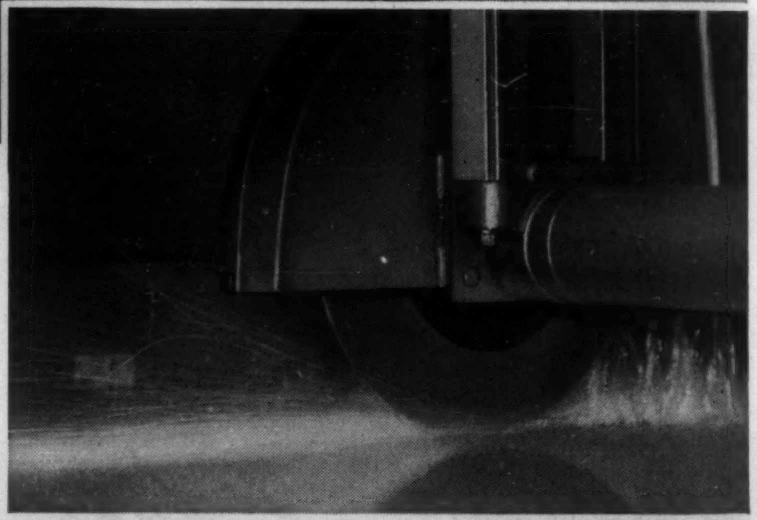
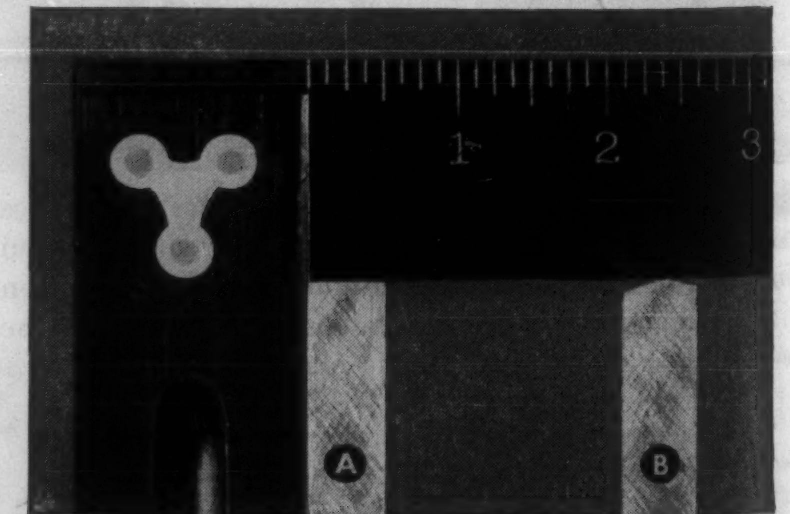
PHILADELPHIA • BUFFALO • SYRACUSE • HARTFORD
LYNDHURST • ROCHESTER • BALTIMORE





Abrasive cutting offers a superior edge that will in most cases reduce edge finishing costs. Note (a) cut on the new Frasse abrasive saw, (b) cut on a conventional shear.

For more information, turn to Reader Service Card, Circle No. 430

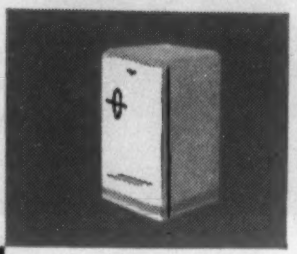
DOW

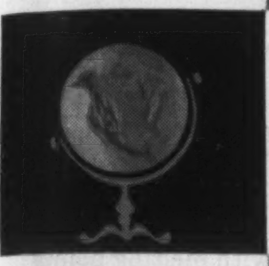
LOOKING FOR NEW AND PROFITABLE DESIGN APPLICATIONS?

Dow has the answer—

STYRON 475 PLASTIC SHEET

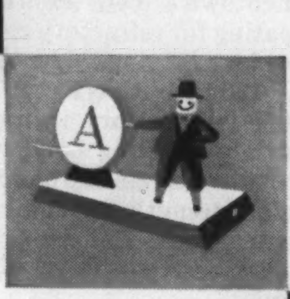
Many complicated refrigerator and appliance parts like freezer doors and crisper boxes are made with easily formed Styron® 475 sheet!



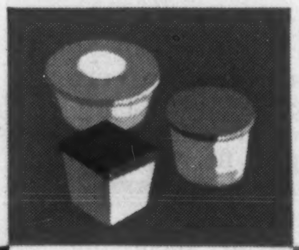


There's no limit to colorful, high-impact Styron sheet's applications in the novelty fields!

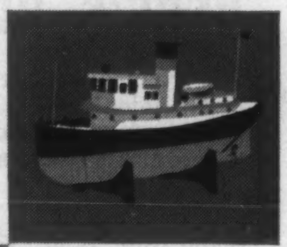
Many beautiful three-dimensional displays and signs are formed of low-cost Styron 475 sheet!

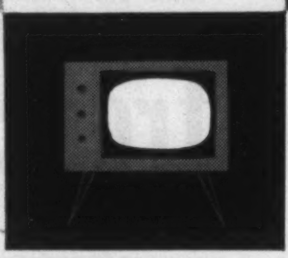


The list of its advantages below shows why more and more packaging men have turned to dependable Styron 475 sheet!



Versatile Styron 475 sheet sets the pace for realistic detail, extra play value and longer play life in today's fastest-selling toys!





Styron 475 sheet is the choice of many radio and TV manufacturers for masks, back and tube enclosures and insulating shields!

YOUR PRODUCT GOES HERE

You can use these Styron® 475 sheet advantages to cut your operating costs—

1. Economical
2. Will not corrode, rust or tarnish
3. Easily formed and fabricated (punched, die-cut, stamped, vacuum-formed)
4. Adaptable to most painting and printing methods
5. Excellent resistance to water and moistures
6. Will not support mildew, mold and fungi
7. Lightweight
8. Chemically compatible with a majority of packaging materials
9. Reusable or disposable
10. Wide range of opaque and semitranslucent colors
11. Nontoxic
12. Has good chemical resistance

Extra advantages—*extra* profits! Those are the keys to the increasing favor Styron 475 sheet is finding with design engineers everywhere. Styron 475 sheet is a high-impact polystyrene formulation produced as a sheet in a variety of sizes, thicknesses and colors. Styron 475 sheet is also available from leading manufacturers in your area. Experienced fabricators in your area can do outstanding work to your specifications. Write Dow today—we'll put our years of plastic sheet know-how to work for *you*. You can count on prompt, personal attention to your specific needs. THE DOW CHEMICAL COMPANY, Midland, Michigan.

Plastics Sales Department, PL 491HH-1
The Dow Chemical Company, Midland, Michigan

Please rush technical data on Styron 475 sheet and nearest source of supply:

Name and title________________

Firm name________________

Types of product manufactured________________

Address________________

City________ Zone____ State________

you can depend on DOW PLASTICS

DOW

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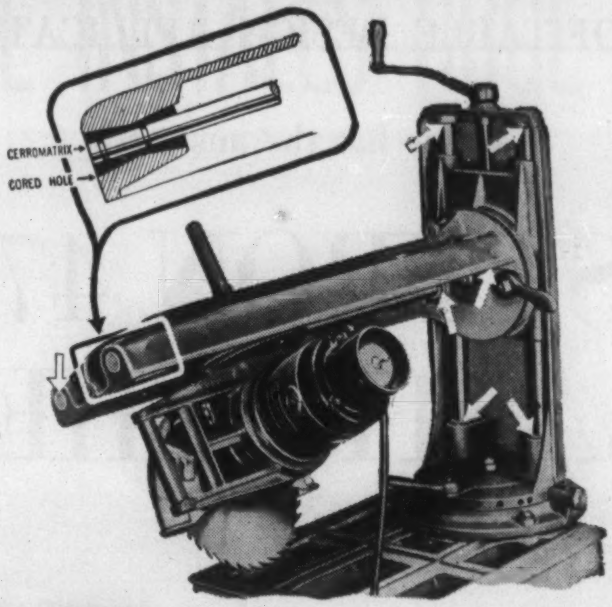
For more information, turn to Reader Service Card, Circle No. 389

Cerromatrix Does It!

Slide Rods
Anchored at
½ Cost of
Machining
for Drive Fits.



HERE'S HOW:

Grooved slide rods were inserted in cored, oversize holes and aligned in a holding fixture. Cerromatrix was melted and poured in place. When frozen, Cerromatrix expanded to give a tight fit that exceeded the life of the machine. Proven by 20 years in service.

Find out how YOU can save money in anchoring bearings, bushings and non-moving parts in machine building by writing for Bulletin A1.

CERRO DE PASCO CORPORATION
312 Park, New York 22, N. Y.

For more information, turn to Reader Service Card, Circle No. 324

NICOTE Metallized Ceramic Coating
...for use with both hard and soft solders!

NICOTE is Frenchtown's new exciting discovery . . . a *single* metallic coating for refractory ceramic bodies which provides a surface for applying solders with melting points between 275° and 1600°. With NICOTE, no buffing, electroplating or tinning is necessary in most applications to form a strong, firmly-adhering bond with either *hard* or *soft* solders. NICOTE's mechanical bond makes it ideal for hermetic seals, high strength mechanical seals, and vacuum applications. Bulletin 155 contains complete engineering details. Write for a free copy today!

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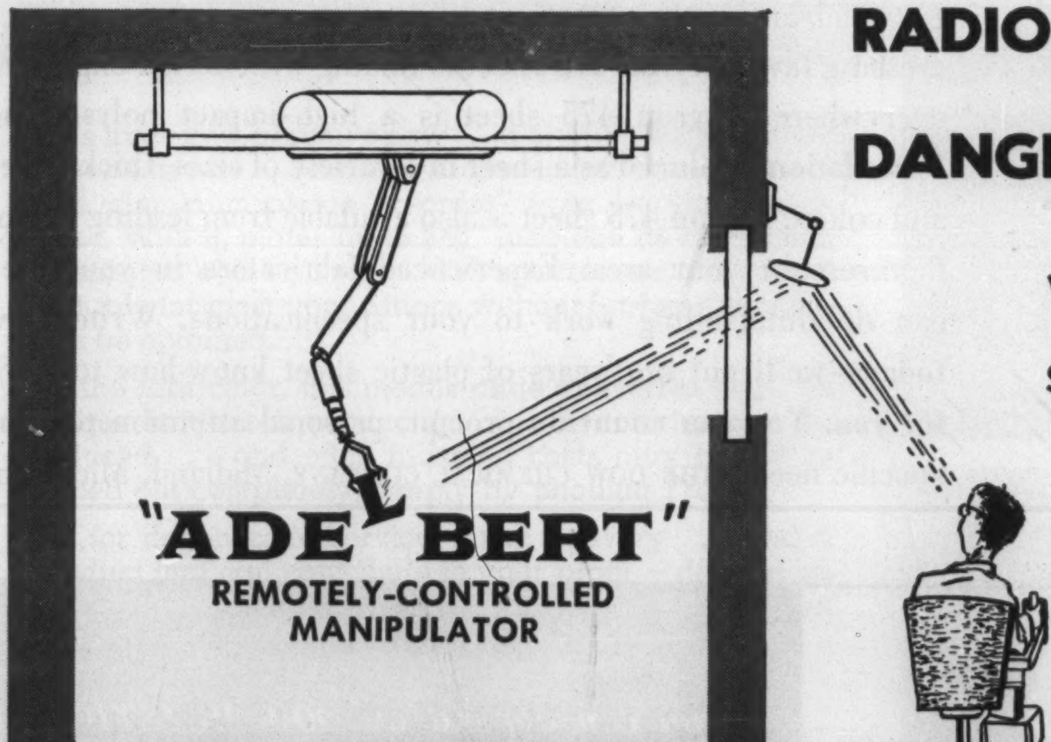
for PRECISE, DELICATE HANDLING of

RADIOACTIVE MATERIALS
AND OTHER
DANGEROUS SUBSTANCES



HERE'S WHY

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SHOULD BE YOUR CHOICE

- Adjustable finger pressure—for handling glassware, etc.—as well as mechanical grip.
- Distance between arm and operator limited only by length of cable connection. TV viewing if necessary.
- Arm action reversible, relative to controlling motions, thus eliminatin confusion where work is viewed by mirror.

For complete information, write for Bulletin A-1 to:

ATOMIC ENERGY OF CANADA LIMITED

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PRODUCTS
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P.O. BOX 93 • OTTAWA, CANADA

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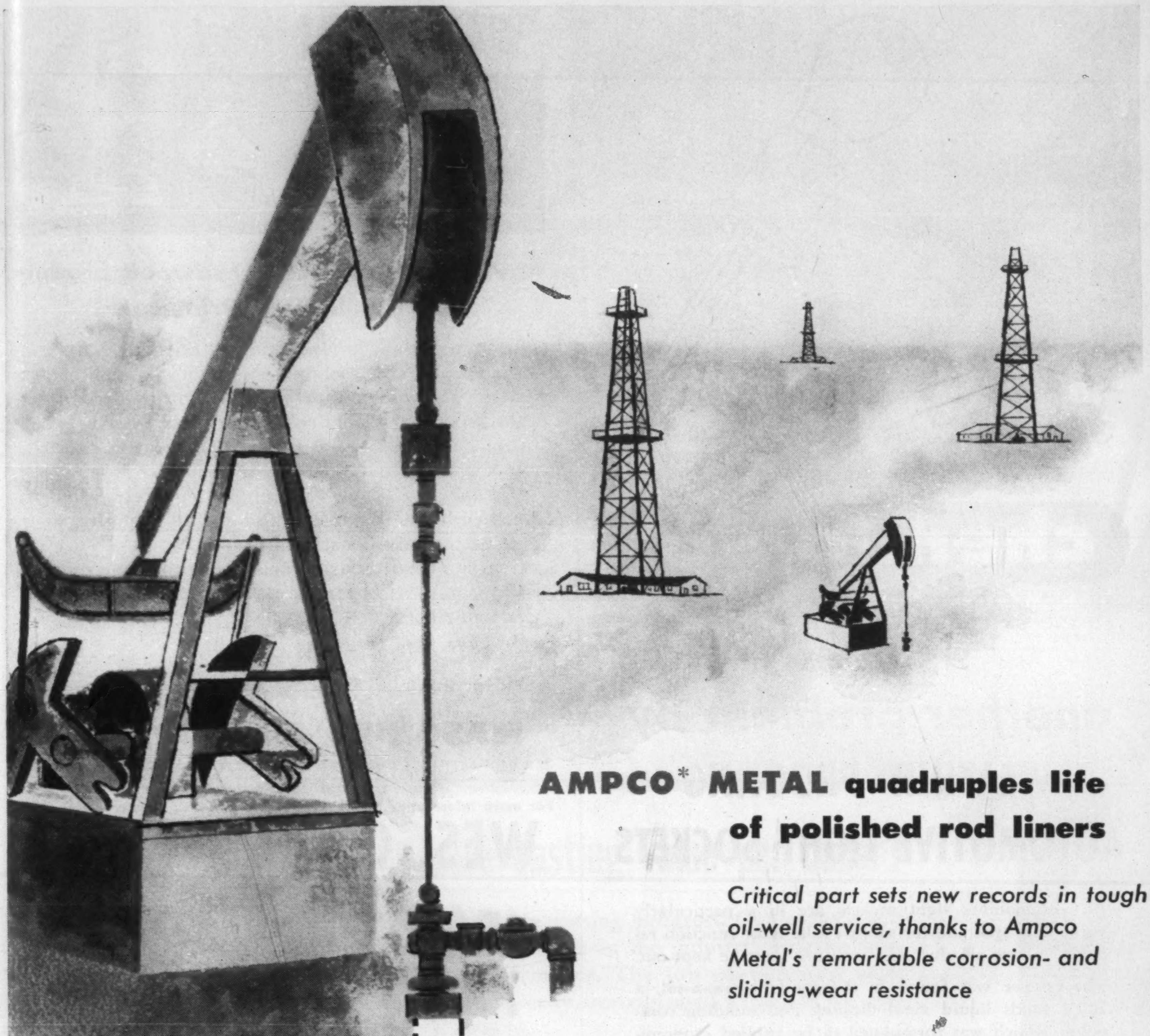

AMPCO* METAL quadruples life of polished rod liners

Critical part sets new records in tough oil-well service, thanks to Ampco Metal's remarkable corrosion- and sliding-wear resistance

In oil well pumping the 14 to 16-foot polished rod liner really takes a beating. As you can imagine, sliding wear, in this extra-long bushing, is a real problem when you consider the number of strokes made by a pump during an operating day. Corrosion enters the picture, too, with the liner often in contact with salt water, sulfides, etc.

With ordinary bronzes, Cities Service Oil Company found frequent replacement to be a constant headache. Then, in certain areas, it switched to liners made from Ampco Metal Pipe. Cities Service engineers report a substantial reduction in liner replacements.

Ampco Metal Liners last four times as long as plain bronze liners because they are made from a unique aluminum bronze alloy. It's a remarkable bearing material—has unusual resistance to mechanical wear. It withstands the corrosive effects of many acids and caustics. And when used as pipe it combats erosion from solids held in suspension.

Ampco pipe and tubing is available in all sizes, along with a complete line of flanges and fittings. Send coupon today for full information.

*Reg. U. S. Pat. Off.

AMPCO METAL, INC. D-45
Dept. MA-12, Milwaukee 46, Wisconsin

I'm interested in knowing more about the wear- and corrosion-resistant properties of Ampco Metal. Please send me complete information.

Name.................................Title.............................
Company...
Company Address...
City.................................(.....) State.......................

AMPCO® **AMPCO METAL, INC.**
Sole Producer of Genuine Ampco Metal

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Milwaukee 46, Wisconsin
West Coast Plant
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socket
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socket
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solves

another problem by

WEATHER - PROOFING

AUTOMOTIVE LIGHT SOCKETS

An automobile's light sockets are in a particularly vulnerable spot and for safety's sake must function reliably. Above all, dust and moisture must be kept out.

The answer was found in the use of **chem-o-sol**, a 100% solids liquid vinyl dipping and molding compound which was formulated to be applied economically on a continuous line production basis. This **chem-o-sol** is not only tough and flexible but has completely sealed the socket from moisture, dirt and chemicals.

Here is another example from our files showing how a product was improved through using **chem-o-sol.**

Chem-o-sols are available for many application methods. New products are constantly being developed and established products improved by spraying, molding, die-wiping and knife- or roller-coating this versatile basic material.

Our completely equipped laboratory and trained chemists stand ready to assist you in formulating the *exact* **chem-o-sol** to improve your product.

Dipped sockets are a product of Watts Electric and Manufacturing Company, Birmingham, Mich.

Write for Bulletin 141

Chemical Products CORPORATION

KING PHILIP ROAD • EAST PROVIDENCE, R. I.

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For more information, turn to Reader Service Card, Circle No. 447

What a difference a coat makes!

Good News!

Any smooth-surface Presdwood product now available in Primecote!

Now you can save more time and finishing costs . . . turn out products with better, longer-lasting finishes.

Hard, tough primer coat is factory-sealed on Presdwood by special coating process. Neutral gray in color, it's an ideal base for paint, lacquer, enamel, silk-screening and wood-grain finishes.

Get the details now! Our engineers will be glad to work with you to get the full benefits from this cost-cutting, quality-boosting Primecote, found only on versatile Presdwood® panels. Address your inquiry to Masonite® Corporation, Dept. MM-12, Box 777, Chicago 90, Ill.

Look for this man He makes the difference

MASONITE CORPORATION

MANUFACTURER OF PRESDWOOD PANEL PRODUCTS

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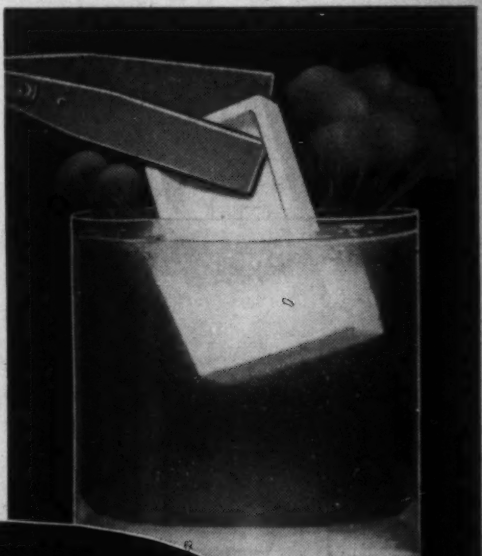
WESGO

CRACK-PROOF

CERAMIC BOATS



for high temperature furnace applications

- Extremely high resistance to thermal shock
- Variety of stock sizes; also available in special shapes to specifications
- Retain shape, stay flat in service
- Unaffected by furnace atmospheres
- Inert to virtually all metals

Boat at 2000° F. plunged into ice water does not crack.

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Write for Brochure

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Zinc Die Casting—
Commercially Trimmed

Aluminum Permanent Mold
Casting—Machined & Velvaglazed®

Aluminum Die Casting—
Commercially Trimmed

Want more casting value per dollar?

Monarch pioneers in casting progress. Our casting and finishing facilities, unique in the industry, produce unusual casting performance. The job your casting must perform is economically accomplished with jobs we perform on the casting.

Illustrated are a few major industries capitalizing on Monarch's ability to guarantee top-value castings at factual, low end-cost.

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PIONEERS IN CASTING PROGRESS

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Aluminum Die Casting—
Commercially Trimmed

Aluminum Permanent Mold
Casting—Velvaglazed®

Aluminum Die Casting—
Commercially Trimmed

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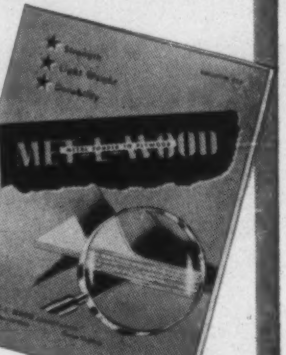
MET-L-WOOD

METAL BONDED TO PLYWOOD

STRUCTURALLY: Like STEEL
WORKABILITY: Like WOOD

● A Met-L-Wood panel ⅜" thick has the same stiffness as a ¼" steel plate—yet weighs only one-third as much! Add to these facts: excellent workability without special tools, inherent sound-deadening, insulating and vibration-damping qualities . . . and smooth, clean surfaces that withstand hard wear, water, and weathering. Isn't there a place for versatile Met-L-Wood in your product planning? Details are yours for the asking in the bulletin described below.



THE ANSWER BOOK ON MET-L-WOOD FOR YOUR USES

Met-L-Wood Bulletin 521 contains 16 pages of technical data, facts and photos to give you a clear, accurate picture of Met-L-Wood characteristics, uses and possibilities. Write for your copy today.

MET-L-WOOD CORPORATION
6755 West 65th Street, Chicago 38, Illinois

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of all nylon ....

for high heat or other severe conditions

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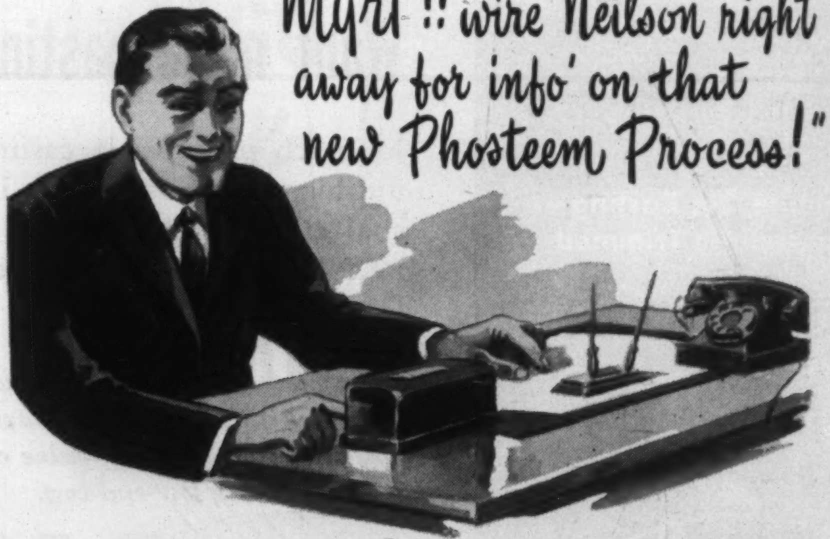

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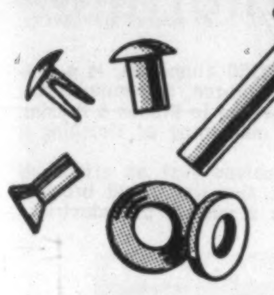
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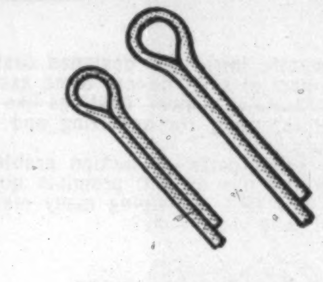
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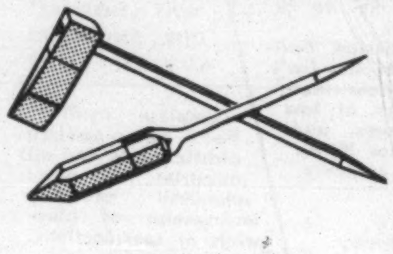
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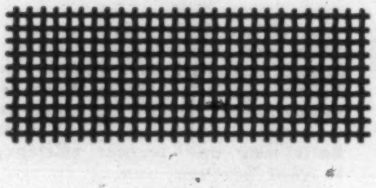
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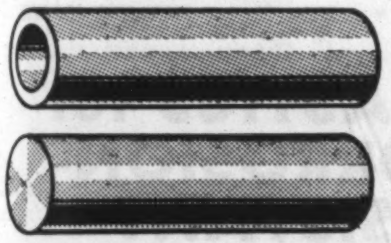
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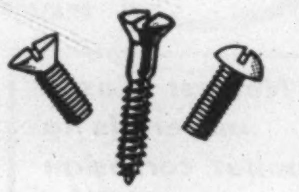
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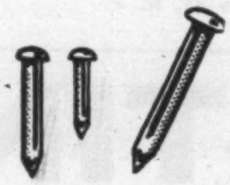
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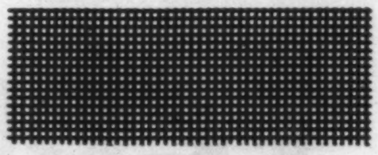
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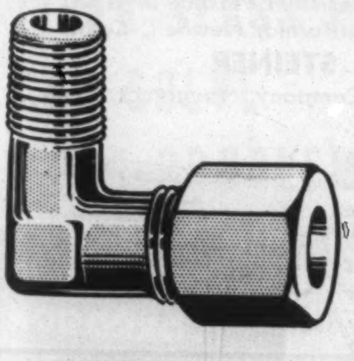
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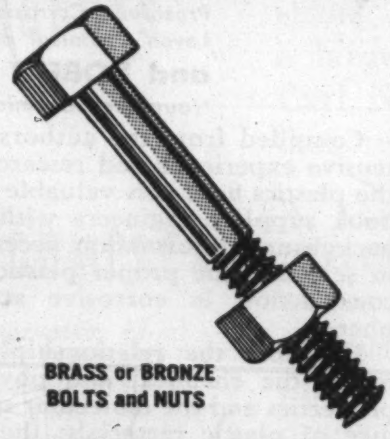
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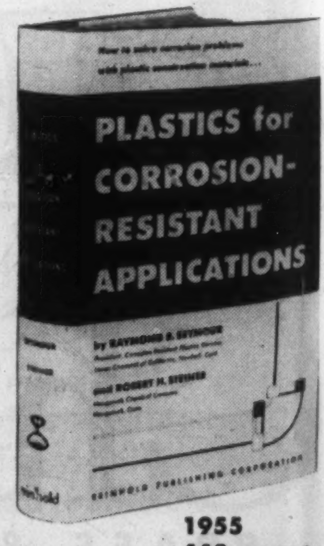

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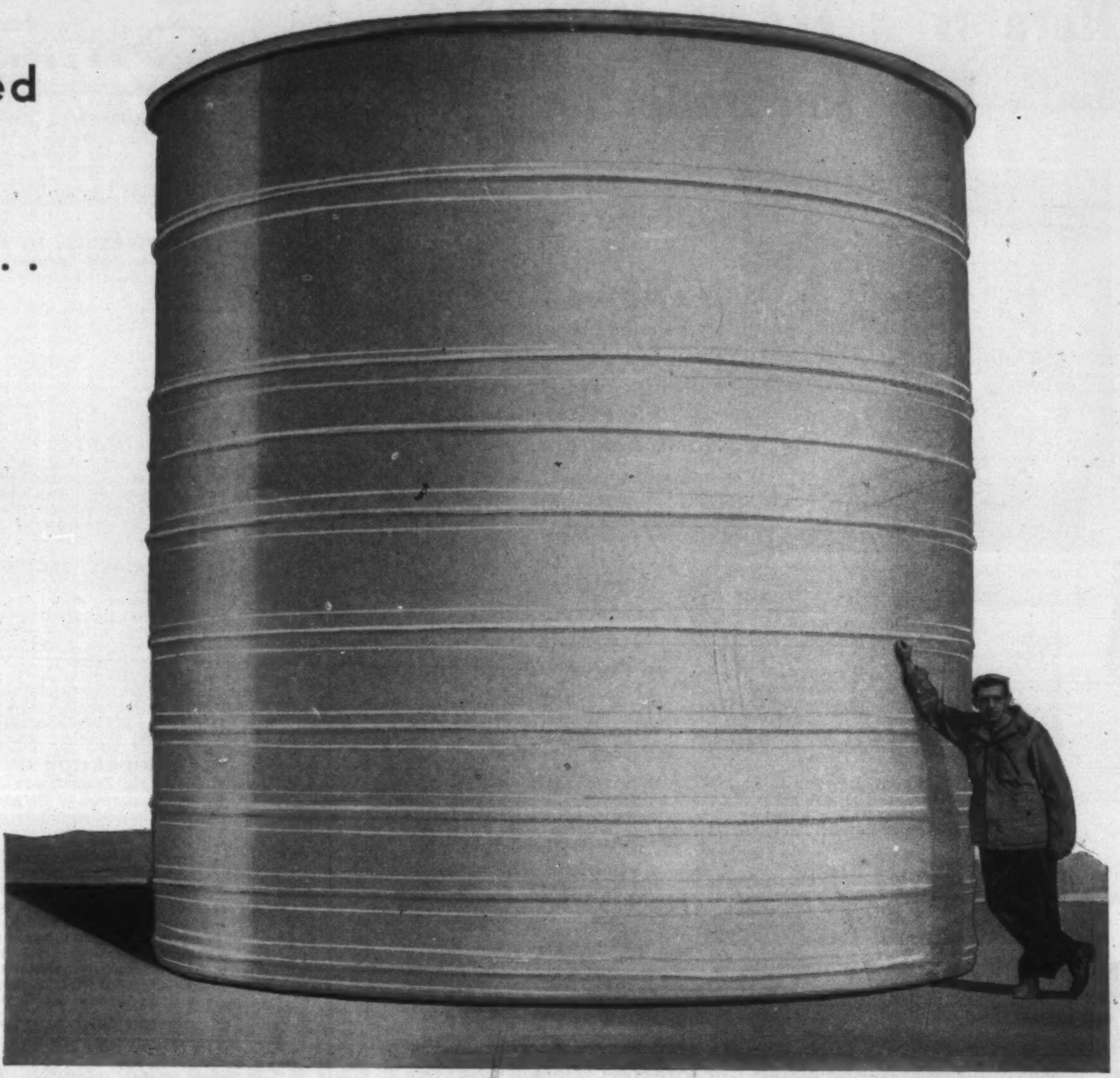

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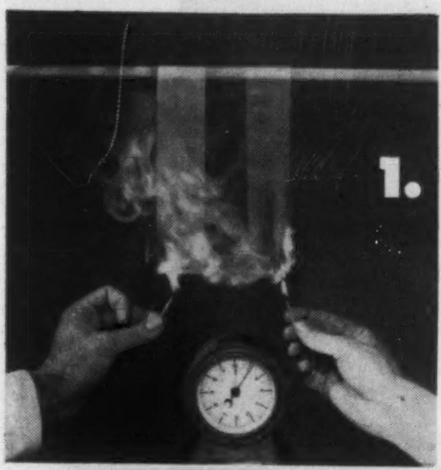

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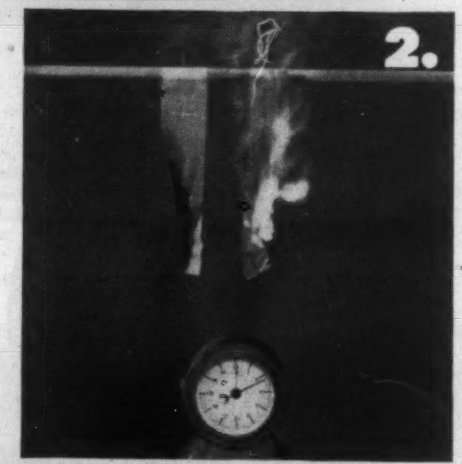

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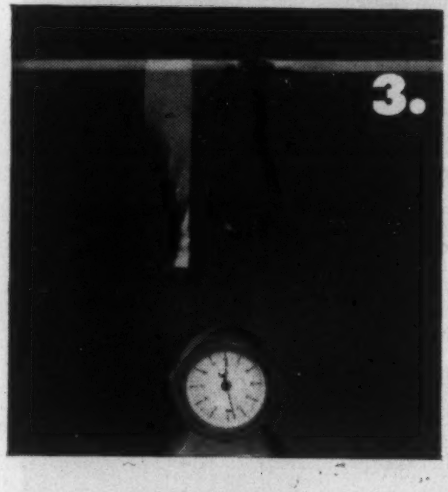

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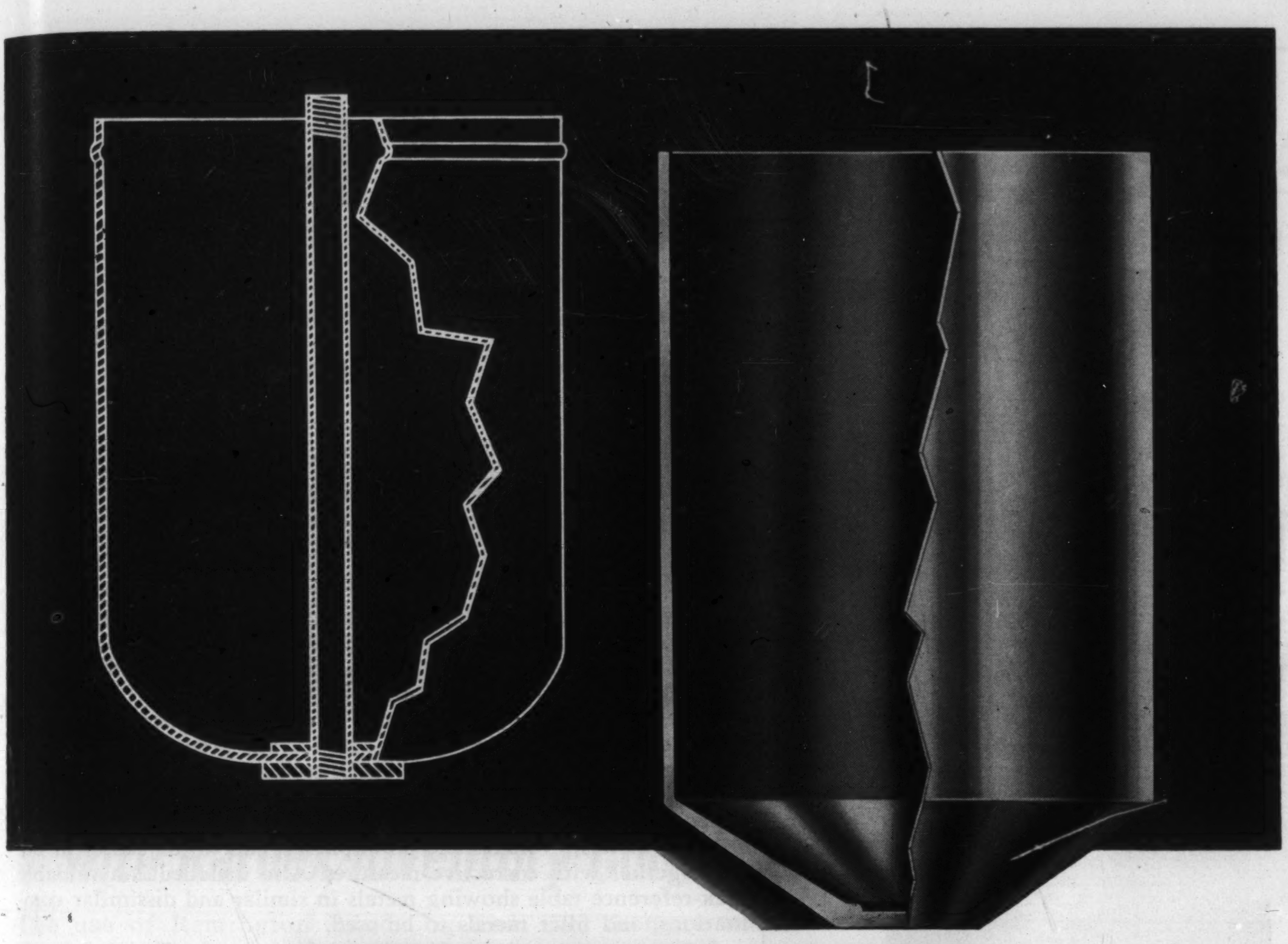

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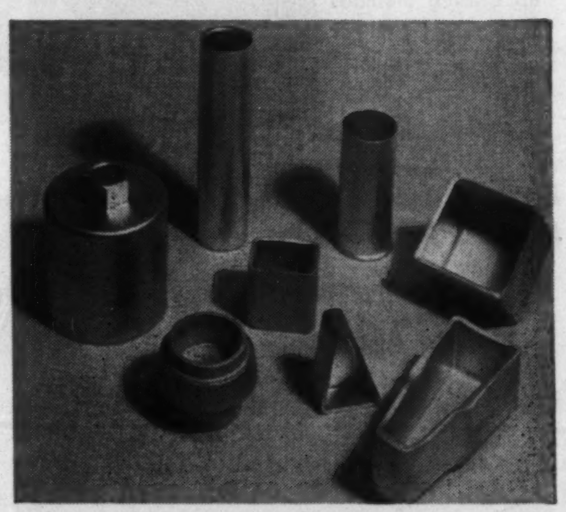

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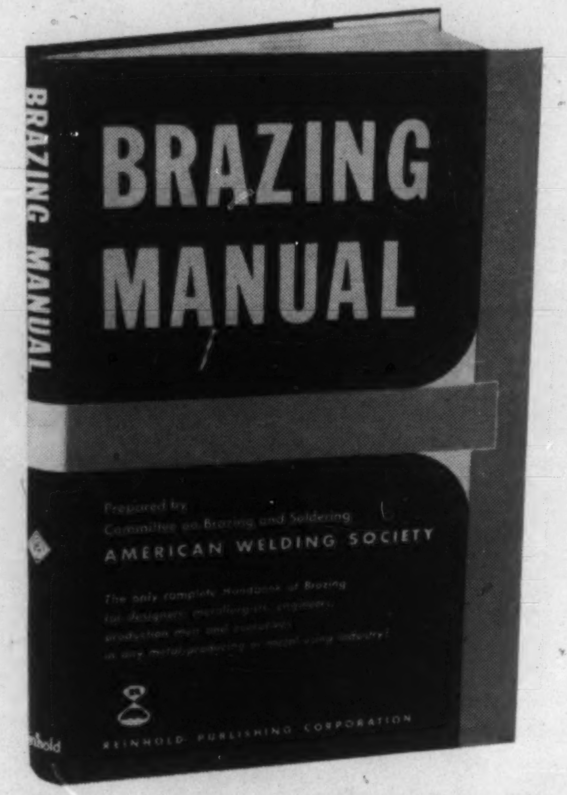
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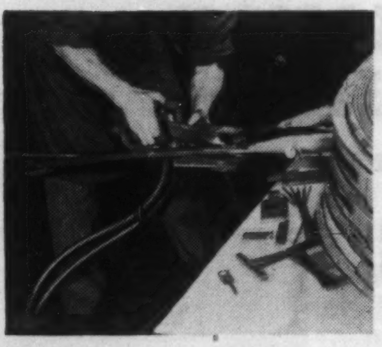

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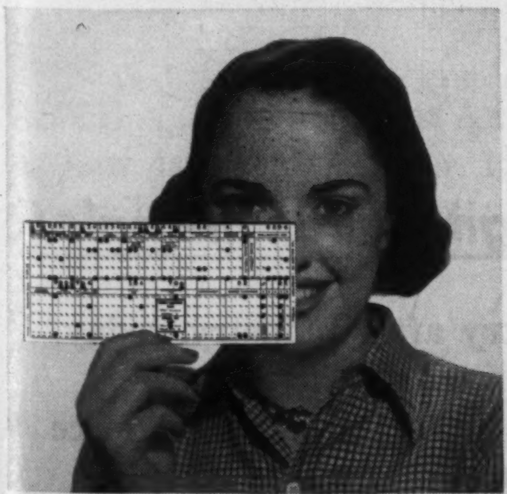

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Profit-Building **IDEAS** For Business

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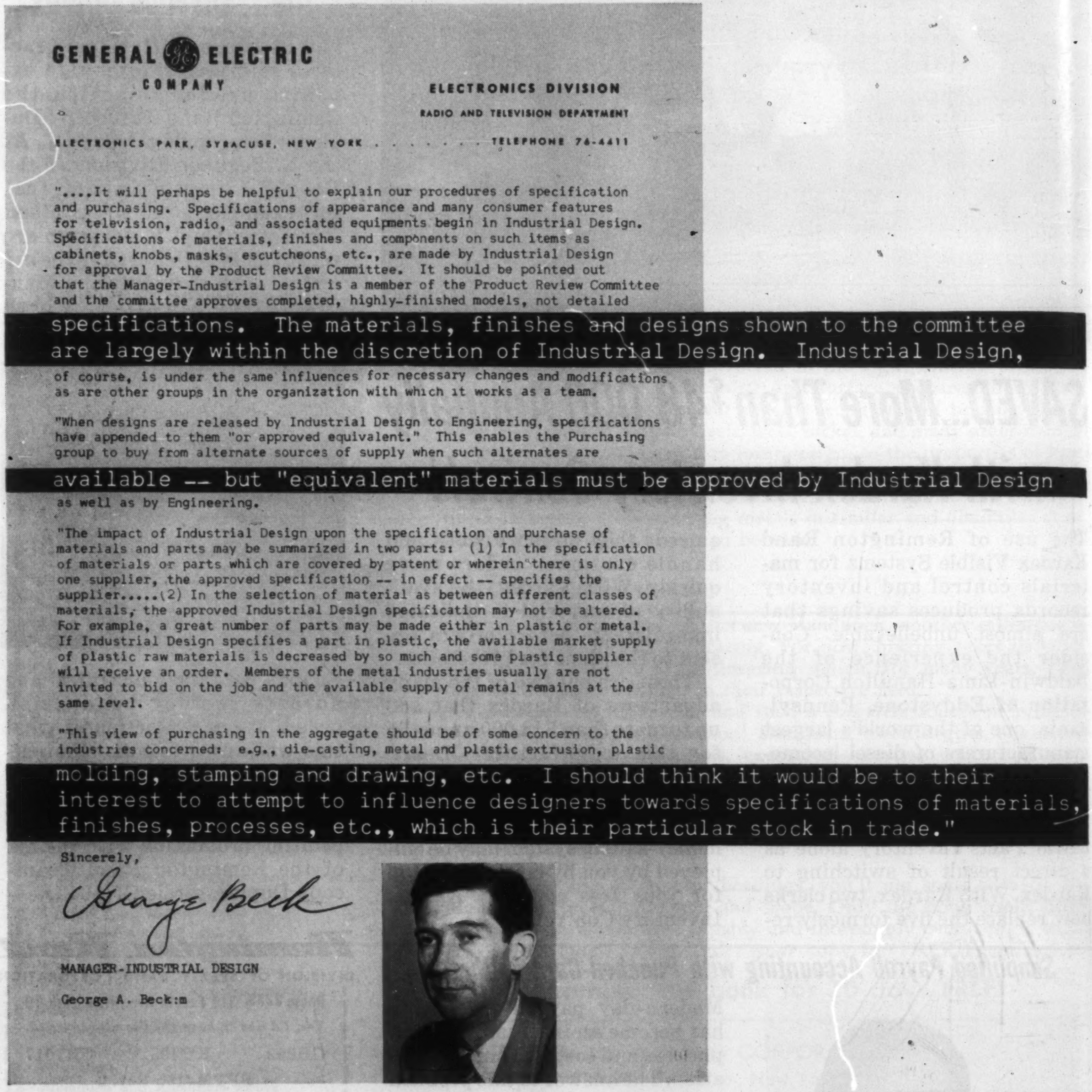
here's how GE specifies materials, components and finishes for radio and television sets



GENERAL ELECTRIC
COMPANY

ELECTRONICS DIVISION
RADIO AND TELEVISION DEPARTMENT

ELECTRONICS PARK, SYRACUSE, NEW YORK . . . . TELEPHONE 76-4411

"....It will perhaps be helpful to explain our procedures of specification and purchasing. Specifications of appearance and many consumer features for television, radio, and associated equipments begin in Industrial Design. Specifications of materials, finishes and components on such items as cabinets, knobs, masks, escutcheons, etc., are made by Industrial Design for approval by the Product Review Committee. It should be pointed out that the Manager-Industrial Design is a member of the Product Review Committee and the committee approves completed, highly-finished models, not detailed specifications. The materials, finishes and designs shown to the committee are largely within the discretion of Industrial Design. Industrial Design, of course, is under the same influences for necessary changes and modifications as are other groups in the organization with which it works as a team.

"When designs are released by Industrial Design to Engineering, specifications have appended to them "or approved equivalent." This enables the Purchasing group to buy from alternate sources of supply when such alternates are available -- but "equivalent" materials must be approved by Industrial Design as well as by Engineering.

"The impact of Industrial Design upon the specification and purchase of materials and parts may be summarized in two parts: (1) In the specification of materials or parts which are covered by patent or wherein there is only one supplier, the approved specification -- in effect -- specifies the supplier.....(2) In the selection of material as between different classes of materials, the approved Industrial Design specification may not be altered. For example, a great number of parts may be made either in plastic or metal. If Industrial Design specifies a part in plastic, the available market supply of plastic raw materials is decreased by so much and some plastic supplier will receive an order. Members of the metal industries usually are not invited to bid on the job and the available supply of metal remains at the same level.

"This view of purchasing in the aggregate should be of some concern to the industries concerned: e.g., die-casting, metal and plastic extrusion, plastic molding, stamping and drawing, etc. I should think it would be to their interest to attempt to influence designers towards specifications of materials, finishes, processes, etc., which is their particular stock in trade."

Sincerely,

George Beck

MANAGER-INDUSTRIAL DESIGN

George A. Beck:m

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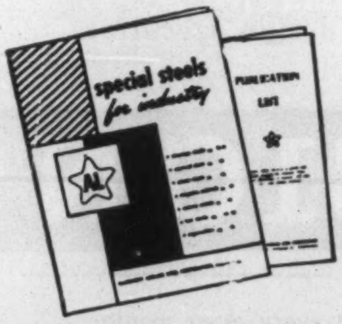

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Slotted tubes extruded from BAKELITE Polyethylene by **Jessall Plastics, Inc.,** Kensington, Conn. for the Exide Industrial Division of The Electric Storage Battery Company, Philadelphia 2, Pa.

Corrosion-Resistant Polyethylene Parts Boost Battery Power, Working Life

The new "Exide" "Ironclad" battery was developed for heavy-duty service . . . for example, powering of lift trucks. It's got the usual dimensions, but it's a bigger battery. According to the manufacturer, it packs 20 per cent more power . . . delivers 100 per cent capacity initially (not the ordinary 85) . . . and its working life is longer than that of earlier models.

New design and a new material made it possible. Finely slotted tubes extruded from BAKELITE Brand Polyethylene hold the active material of the positive plates. They permit maximum exposure to the electrolyte. And being BAKELITE Polyethylene, they don't corrode and shorten battery life. To complete the picture, the bottoms of the tubes are closed with sealers molded from BAKELITE Polyethylene.

Corrosion resistance is just one important advantage of BAKELITE Polyethylene. This material is readily molded or extruded into finely detailed shapes. It is the lightest commercial plastic. Dielectric properties are outstanding. It is supplied in a wide range of colors.

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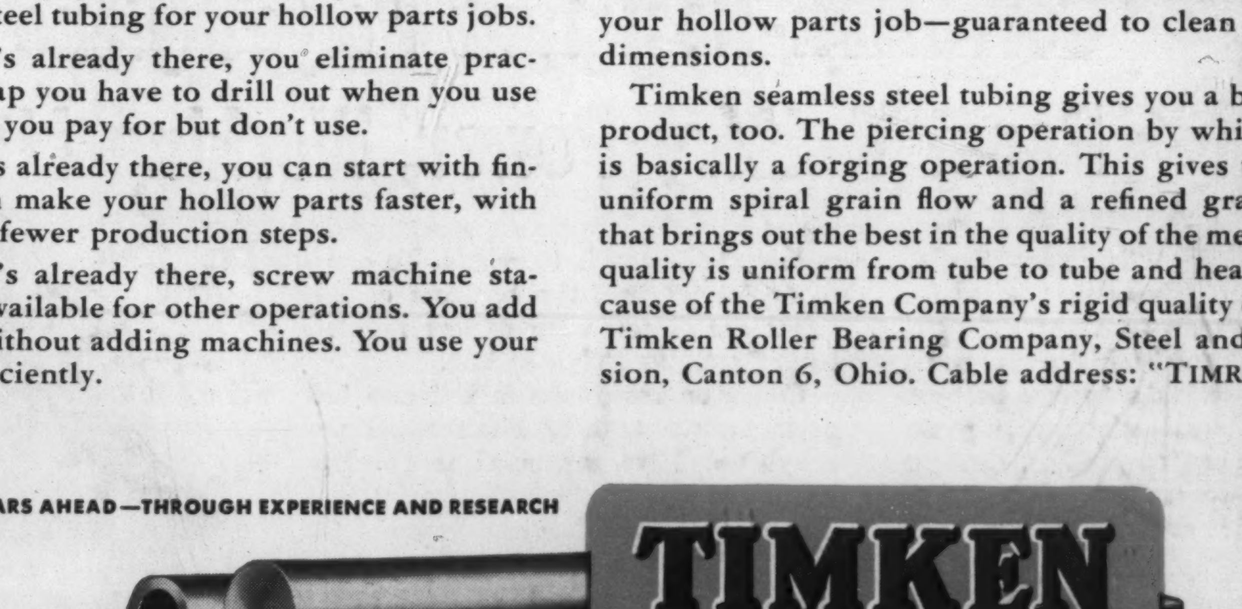

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